DOCUMENT RESUME

ED 139 904 95 CE 009 933

AUTHOR	Wendel, Robert, Ed.; And Others
TITLE	A Teacher's Guide to Metrics. A Series of In-Service Booklets Designed for Adult Educators.
INSTITUTION	Ohio State Dept. of Education, Columbus. Div. of Federal Assistance.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
BUREAU NO	018A76SD
NOTE	135p.
EDRS PRICE	MF-$0.83 HC-$7.35 Plus Postage.
DESCRIPTORS	Adult Basic Education; Adult Education Programs; *Adult Educators; Adult Learning; Decimal Fractions; Guidelines; High School Equivalency Programs; *Inservice Teacher Education; Instructional Materials; *Learning Activities; Measurement; *Metric System; Program Administration; Teaching Guides; Temperature; *Units of Study; Weight

ABSTRACT

This series of seven booklets is designed to train teachers of adults in metrication, as a prerequisite to offering metrics in adult basic education and general educational development programs. The seven booklets provide a guide representing an integration of metric teaching methods and metric materials to place the adult in an active learning environment, with learning activities arranged to help the adult learn metrics by actually using metric measures. The first section of booklet 1 contains a general introduction to the series and to metrics instruction; the second contains guidelines for conducting inservice sessions on metrication; the third section is an evaluation of selected metric equipment. Booklets 2-7 each contain from one to four units of instruction for teacher inservice sessions. Unit contents include objectives, teaching strategies, teaching evaluation, sample written exercises, and lists of resources. The units in their respective booklets are as follows: Booklet 2--understanding the need for metrics, understanding calibration, the decimal system, and understanding prefixes; booklet 3--measuring length, and determining area; booklet 4--measuring volume; booklet 5--measuring weight; booklet 6--determining temperature; and booklet 7--conversion between metric units. (Although the series could be used by adult educators for self-study, the authors recommend that it accompany inservice sessions led by trained metric educators.) (MF)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

ED139904

A Teacher's Guide to Metrics
A Series of In-Service Booklets Designed For Adult Educators

Robert Wendel
Editor

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

CE 009 933

A TEACHER'S GUIDE TO METRICS

A Series of In-Service
Booklets Designed for
Adult Educators

?
CM
LITER
GRAM
OZ.
GALLON
1 FOOT

BOOKLET
1

BEFORE YOU BEGIN TEACHING METRICS

Robert Wendel, author and editor

A TEACHER'S GUIDE TO METRICS

A Series of In-Service
Booklets Designed for
Adult Educators

Booklets in This Series

Booklet One:	Before You Begin Teaching Metrics
Booklet Two:	Metric Readiness
Booklet Three:	Measuring Length and Area
Booklet Four:	Measuring Volume
Booklet Five:	Measuring Weight
Booklet Six:	Determining Temperature
Booklet Seven:	Conversion Between Metric Units

This guide was developed pursuant to project No. 018A76SD with the Division of Federal Assistance, Ohio Dept. of Education. The activity which is the subject of this report was supported in whole and in part by the U.S. Office of Education, Department of Health, Education, and Welfare. However, opinions expressed herein do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

Diane Girard, Dayton Public Schools

Robert Wendel, Miami University

Co-Directors

A Teacher's Guide to Metrics Series

Booklet One

Page

Before You Begin Teaching Metrics................1

Guidelines for Conducting In-Service.............6

Selected References:
Equipment, Materials, and Books...........10

Before You Begin Teaching Metrics

This Teacher's Guide to Metrication coincides with the U.S. commitment to adopt the metric system. At the end of 1975, President Ford signed a bill which will speed the U.S. changeover to the metric system. The government, functioning through a 17-member Metric Board, will organize, schedule, and coordinate the conversion to the metric system.

National Educational Assessment indicates that adults, presently, do not comprehend metric measurements. If adults are to learn metrics, and they must, training teachers of adults in metrication is a prerequisite to offering metrics in ABE-GED programs. As metrication becomes more prominent in industry and daily life, adults who understand metrics will gain relevancy in daily living and job opportunities. Adult educators trained in metrics can answer the growing number of questions adults have about metrics and its relationship both to their lives and jobs. For some adults, ABE-GED programs may be the only opportunity they have to learn metrics. Thus, all teachers must be prepared to teach metrics.

As a pilot project, selected adult educators from southwest Ohio were trained in metrication. Activity oriented training sessions for these educators were coupled with the trial use of metric materials and inquiry techniques in their adult education classes. Both techniques and materials were evaluated by participants for appropriateness in ABE-GED classrooms. Cost, availability, and teaching-learning effectiveness were also determined through field testing. Refinement of metric methods and materials followed field testing.

This guide represents an integration of metric teaching methods and metric materials that purposely places the adult in an active learning environment. By actually "doing metrics", learners will comprehend metrics more quickly and be able to "use" metrics everyday. The authors have selected a sequential approach to teaching metrics. Learning activities are designed to help the adult learner conceptualize metrics by estimating and calculating metric measures. Active discovery-oriented teaching methods sequentially presented contribute positively to adult learning.

Special features of the guide include sections on two areas crucial to proper understanding of metrics. First, a thorough review of decimals enables the adult student to better comprehend metrication. Second, calibration is presented as a topic essential to reading rulers and making correct measurements. Both topics are supported by instructional activities that lead the adult student to learn by doing.

The use of diagnostic testing to determine deficiencies followed by remediation of these deficiencies is advisable. Each booklet in the guide includes objectives, activities, and sample written exercises of all major metric topics. This allows both teacher and student to individualize instruction by assigning particular metric topics according to needs. Pre-tests need not always be written. Student fear and "pressure" can be reduced by using a discussion technique to determine a small group's understanding of metrics. Thus, pre-tests for each metric subject are not included in the guide.

Final reviews of metric topics are important in providing feedback on learning. Evaluations assist both the student and teacher in determining the degree of metric mastery and comprehension. The sample written exercises included in each booklet need not always be administered in written form; rather, they can be used as guides for oral evaluation.

However, the guide should not be viewed as all-inclusive. While it offers suggestions for teaching metric concepts using activities, these methods are only springboards for adult educators to develop their own approaches. Adult educators recognize the broad levels of abilities in adult students. Whether these individual differences are do to socio-cultural, economic, or educational levels, materials need adapting to encourage learning. The suggestions in this guide may also need some revision by the teacher to best facilitate adult learning due to individual needs.

When student attendance is erratic or limited, as it frequently is in adult education, the separate metric booklets can be used individually and independently according to student need. Whenever possible, the teacher should review missed metric materials with a student. Another student who has attended regularly and has an understanding of a metric concept can serve as a tutor to the student.

The nature of everyday measurement will never be an exact science; rather, it may strive for a degree of accuracy that is impossible to determine and inappropriate for everyday living. Teaching metric measurement should be approached as a measurement that is relatively "close enough" or "in the ball park." The exact weight in milligrams of a can of apple juice or the exact measurement of a room for carpet "down to the millimeter" is important, perhaps, only in a factory. It should be stressed that everyday metric measurements are less precise.

It is important that teachers try to accommodate and encourage student learning. Various metric units are sometimes spelled differently than they might be in the United States. This is due to an agreed upon international spelling; for instance, litre. The teacher should feel free to select which spelling is best for himself and for his students. See the chart below for examples:

INTERNATIONAL	AMERICAN
litre	liter
metre	meter
kilometre	kilometer
da = deka	dk = deka

The teacher should probably become familiar with both types of spelling. If students seem to accept the international spelling best, then that spelling should be used. If American spelling helps the students learn metrics, use it! This guide will consistantly use an American spelling of metric units.

Although the guide could be used by adult educators as a book for self study in learning metrics, the authors strongly recommend the guide accompany in-service sessions lead by trained metric educators. The guide is not designed to replace in-service.

This guide to teaching metrics has some self-imposed limitations. Recognizing the many demands presently placed on the teacher of adults, the guide purposely limited its suggested methods and materials to ones proven highly effective in field testing.

A variety of activities are offered. Not all of them, though, may be necessary to achieve an objective. The suggested activities are only for guidance. You will need to select or develop activities and exercises according to the level and interests of your students. Those examples in the guide are a beginning.

Extensive citing of references was likewise kept at a minimum for the above reasons. However, a variety of resources are cited for consideration by teachers.

Realistically, metrication does not presently have a high priority in ABE classrooms. Therefore, the time allocated for metrics may, by necessity, be minimal. However, a substantial framework can be laid in a few hours. While you may not cover metrication in depth, the concepts and elimination of fear and mistrust of this system will remain with the student. A little time invested will help the student adjust to his changing world.

A basic assumption inherent in the guide is that the teaching of conversions from present English measures to metric units is counter-productive. Once a student has conceptualized the metric system, metric thinking will become as natural as inches and pounds.

There are some metric units not discussed in the guide. Only those units most common and useful are stressed. Units for measuring the intensity of light, air pressure, and electrical current, for instance, could be taught if adults demand it. Any good reference book will elaborate on these units if needed.

As is true in life, a sense of humor is essential. So it is in teaching metrics. Learning metrics should be fun; teaching metrics can be fun. This guide attempts to introduce metrics in a fashion that invited the enjoyment of learning something new and useful.

You may be somewhat anxious about metrics yourself. In fact, the guide could be subtitled "Things You Didn't Want to Know About Metrics, But Were Asked Anyway." As an adult educator, you are probably use to the challenges presented in ABE-GED. Having the guide to metrication as a resource will enable both you and your student to feel good about becoming masters of metrics.

The co-directors gratefully acknowledge the invaluable assistance in this project of the adult educator participants, consultants, Johnny Hill, Bill Rouse, Dan Franzblau, Kay Trusty, and project assistant Meryl Lederman.

Guidelines for Conducting In-Service

Frequently the question is asked, "How should one plan for in-service sessions on metrication?" In response to that concern, this section outlines the basic components of metric in-service.

1. A resource person knowledgeable in metrication is essential. Not only should this person be familiar with metrics, but competence in instructional methods is highly advisable. This person may be one of the project participants trained in metrication. If so, that person is familiar with metric methods and materials and is capable of conducting in-service sessions.
2. It should be emphasized that a single session dealing with metrication is inadequate for even minimal staff competence. As an introductory overview of metrics, a single afternoon session would be appropriate. What is essential to developing metric mastery is a series of separate in-service sessions dealing with individual metric topics. Ideally, weekly sessions for three to five consecutive weeks under the leadership of a resource person would tend to ensure metric comprehension.
3. Either before or during the in-service, it is advisable to make these preparations:
    - A) Survey and identify metric resources that may exist in local industries, businesses, and school systems. (Suggestions are included in the Guide.)
    - B) Have available for participant use a basic supply of metric materials necessary for training teachers and for use in the ABE-GED classrooms. The following represents a minimum listing of

of metric materials essential for each person. Purchasing kits of metric materials is unwise because not all of the items are needed; also, the use of genuine workaday tools should be encouraged as much as possible.

Basic Metric Materials

Individual Materials
(for each student)

- 30cm rule (cm and mm calibration)
- 25cm rule (cm calibration only)
- flexible meter stick
- package of centimeter cubes
- 5ml spoon
- Celcius thermometer
- area measuring grid (25cm X 25cm)
- 150cm tape measure

Shared Materials
(for 3-5 students)

- set of 3 graduated beakers (250ml, 500ml, 1000ml)
- set of 5 nesting measures
- moving fulcrum scale
- set of plastic weights
- 3 meter steel tape
- cubic liter
- kitchen scale (grams)

C) It is not mandatory that books or films be available for in-service. The materials listed above are adequate and when explained by the resource person, more meaningful for the learner. If the film, "A Metric America", is available, it could be used effectively as an introduction to metric.

4. Learning metrication is made easier by using metric materials; therefore, participants should be encouraged to actually "do" metric activities. Each participant needs to estimate and then actually measure to achieve metric understanding. Making sure each learner does the activities will ensure meaningful learning.

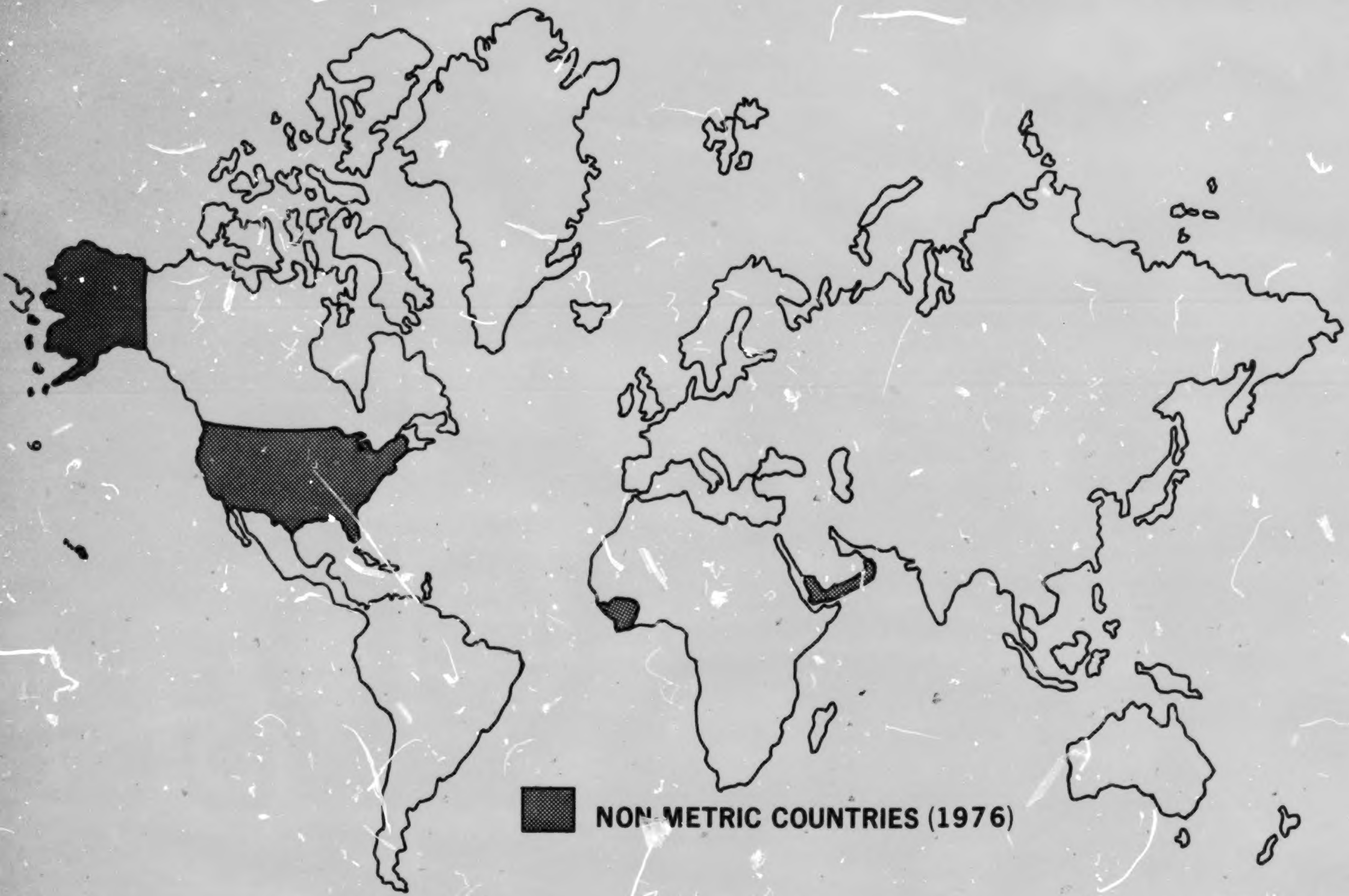
5. Topics that might be trouble spots in metrication need to be carefully presented and reviewed. Decimals

and calibration usually require more time and attention than other topics.

6. Metrication is not a passing fad. It is here to stay and to be used by people daily. In order for adults to learn metrics, the center should make the following commitments:

   A) To implement metrics into ABE-GED programs.
   B) To purchase basic metric materials for use by the students and teachers at the center.
   C) To provide curricular and instructional leadership in metrication.

If the above six suggestions can be honored in preparing the staff to teach metrics, then centers will have trained personnel and have added strong metric components in their adult programs.


▨ NON-METRIC COUNTRIES (1976)

Evaluation of Selected Metric Equipment

cubic liter	(Dick Blick Company, Galesburg, Illinois) Made of clear plastic, the cube is calibrated in 100ml divisions. Participants evaluating this piece claimed it was easy to use, durable and was helpful in reinforcing the concept the liter is based on.(10cm X 10cm X 10cm)
25cm rule	(Dick Blick Company, Galesburg, Illinois) Participants found this to be effective in measuring short lengths. The calibrations are practical and easy to read.
nesting measures	(Dick Blick Company, Galesburg, Illinois) Participants found these liquid measures durable and very helpful in giving the student help in estimating volume. The calibrations were easy to read and practical.
5ml spoons	(Dick Blick Company, Galesburg, Illinois) These spoons closely resemble teaspoons and prove to be helpful in learning small volumes. Participants found them useful in cooking.
cm cubes	(Dick Blick Company, Galesburg, Illinois) These cubes proved helpful in teaching the relationships between cm^2 and cm^3. Participants found them practical and useful in a variety of metric lessons.
meter stick	(Dick Blick Company, Galesburg, Illinois) 2 versions of the meter stick serve different purposes in teaching. One stick is calibrated vertically as to help in measuring on a wall or a person's height. A second version is calibrated horizontally for other measuring purposes. Both are made of flexible plastic as to resist breaking
Celsius thermometer	(U.S. Metric Association) This thermometer is calibrated in degree marks and is a good tool in the comparison of everyday temperatures. The backing is plastic and the calibrations are easy to read.

area measuring grid	(Dick Blick Company, Galesburg, Illinois) This tool is made of clear plastic and is calibrated in cm^2. Participants proved it to be excellent in the teaching of area and square measurements.
fulcrum scale	(Dick Blick Company, Galesburg, Illinois) This scale is used in measuring small weights from 0 to 125 grams. It has a cup with a pouring lip that is graduated from $25cm^3$ to $150cm^3$. This is helpful in teaching the relationship between volume and mass.
personal scale	(Dick Blick Company, Galesburg, Illinois) This is an everyday household scale helpful in estimating large weights. It is calibrated up to 125 kilograms.
150cm tape measure	(LaPine Scientific Co., Chicago, Illinois) This tape measure was found useful in measuring objects without flat surfaces. It is made of cloth coated in plastic and is calibrated in both millimeters and decimeters.
liter set	(LaPine Scientific Co., Chicago, Illinois) This set contains different shapes of containers, each holding one liter of liquid. Participants found these useful in teaching the concept that 1 liter of water weighs 1 kilogram.
balance scale	(LaPine Scientific Co., Chicago, Illinois) This as a sturdy metal scale which allows the student to study relationships by weighing weight against weight. The weights vary from 1 to 5 grams. Each pan has a pouring spout to aid in weighing loose substances.
cubic meter	(LaPine Scientific Co., Chicago, Illinois) This skeleton cubic meter shows the actual size of a cubic meter. Participants found it useful in estimating size.
trundle wheel	(Invicta International Educators, Leicester, England) This wheel has a circumference of 1 meter. It was found to be helpful in measuring long distances.

CE 004 933

Metric Measurement Kit (Xerox Education Publications)
This kit consists of 6 units, each dealing with a different phase of metrics. Each unit consists of filmstrips, a record, duplicating masters, and teacher's notes. Participants found this useful as an introduction to metrics but may be better suited for an elementary or secondary teaching level.

Metric Masters by Sylvia Hoffman (Holt, Rinehart, and Winston)
A collection of duplicating metric worksheets. Participants found these useful as exercises in all areas of metrics.

Let's Measure Metrics (Ohio Department of Education)
A workbook geared toward adult education. This book was used in this project for exercises and work stations and was found to be most effective.

Metrics for Home Use by Opal Massey (Willow House Publishers)
This book is geared toward adult learning for use in everyday situations. It deals with cooking, sewing, shopping, etc.

The Metric Pal by Jesse D. Wallace, 1078 E. 5th Ave., Chico, CA.
This workbook deals with the SI metric system on an adult level. Besides the common areas of metrics, the book deals with velocity, torque, pressure, energy, density, speed, and acceleration.

A Metric America (Aims Instructional Media Services)
This film proved to be a good introduction to the metric system. It gives good insight into why America should go metric.

The Metric System (Visual Instructions Productions)
This 6 unit presentation consists of a super 8 color film and teacher's notes for each unit. These films have proven to be good introductions to each unit as they are taught.

BOOKLET

2

METRIC READINESS

A Teacher's Guide to Metrics

Diane Girard, author
Robert Wendel, editor

OZ.
1 FOOT
GALLON

A TEACHER'S GUIDE TO METRICS

A Series of In-Service
Booklets Designed for
Adult Educators

Booklets in This Series

Booklet One:	Before You Begin Teaching Metrics
Booklet Two:	Metric Readiness
Booklet Three:	Measuring Length and Area
Booklet Four:	Measuring Volume
Booklet Five:	Measuring Weight
Booklet Six:	Determining Temperature
Booklet Seven:	Conversion Between Metric Units

This guide was developed pursuant to project No. 018A76SD with the Division of Federal Assistance, Ohio Dept. of Education. The activity which is the subject of this report was supported in whole and in part by the U.S. Office of Education, Department of Health, Education, and Welfare. However, opinions expressed herein do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

Diane Girard, Dayton Public Schools

Robert Wendel, Miami University

Co-Directors

Metric Readiness

Booklet Two

Unit | Page

1. Understanding the Need for Metrics........... 1

2. Understanding Calibration..................... 7

3. The Decimal System........................... 13

4. Understanding Prefixes....................... 21

Unit 1

Understanding the Need for Metrics

Unit Objectives:

The student should be able to:

1. Identify how metrics already affects our lives.
2. Identify reasons for switching to metrics.

Like it or not, metrication is upon us. Manufacturers, recognizing a potential market, are producing metric tools and conversion devices. Calculators for converting American and metric measurements are being marketed. Metric instructional materials abound since elementary schools have begun teaching metrics.

Most people do not realize that metrics are already an accepted part of life. Film and camera types are measured in millimeters. Doctors order so many cc's (cubic centimeters) for an injection. American physicians and druggists have been prescribing and dispensing medicine in millimeters and milligrams since the 1950's. Cigarettes are advertised as "one silly millimeter longer" or reduced a few milligrams in tar and nicotine. Roadsigns already post the distance in kilometers. All newly designed cars are built according to metric specifications, including engines measured in liters. Some food containers such as milk cartons and cookie boxes currently are marked in both the American and metric units. Perhaps you noticed this canning season that Mason jars are already marked in metric units. Olympic events, such as the 100 meter dash and ski jumping, are measured metrically. Skis are already manufactured in centimeter lengths. Metric measurements have been slowly creeping into our lives.

The arguments for a full conversion to the metric system are convincing. Since the U.S. is involved in international trade, many industries are forced to maintain double inventories; one in the American system and one in the metric. Converting to the metric system will save billions of dollars every year and help increase trade. Already, the European Common Market has declared that it will refuse to trade in any non-metric materials beginning January, 1978.

The rest of the world adopted the metric system because it is relatively simple and logical. When examined with an open mind, one can see some *distinct advantages* of the metric system over the American system.

1. *The metric system* is based on the decimal system -- the same system on which our numbers and money are based. Therefore, changing a measurement from one unit to another simply involves moving a decimal point. Memorizing conversion figures (12 inches equals 1 foot; 3 feet equals 1 yard; 5280 feet equals 1 mile) becomes unnecessary. An inspection of the history of the American system is both humorous and enlightening.
2. *Identification* of basic units of measurement is streamlined. Metric units use one of three possible roots:

   Meter for length. *Liter* for volume.
   Gram for weight.
3. The *names* of the different sizes of units are consistent, regardless of the type of unit.
   Smaller units are always labeled with one of these prefixes:
   deci- *centi-* *milli-*
   Larger units are always labeled with one of these prefixes:
   deka- *hecto-* *kilo-*
4. *Relationships* exist between the units of length, volume, and weight. No such consistent relationship exists in the American system.

Children will have the opportunity to learn metrics in school. Adults, however, will be at a disadvantage. Many will be forced to learn it on their own or will fall prey to the many conversion tables, charts, and guides currently on the market. The ABE student should have the opportunity to internalize the material and to develop a working mastery of metrics for everyday usage.

In teaching metrication, it is imperative that the ABE student indentify and understand his reasons for learning metrication. Many ABE students have expressed an interest in metrication since their children began learning it in school; other students find it is job-related. It is just as important, though, for the teacher to understand each student's motivation for learning it. Each student's reasons -- whether it be keeping up with the children, preparation for the GED, using metrics in a job, or curiosity and personal satisfaction -- should have a bearing upon the methods used by the teacher.

Teaching Strategies

1. A *group discussion* is the most frequently used method of introduction. The discussion should be directed towards establishing the following points:
    1. the need for studying metrics.
    2. the relevency of metrics.
    3. creating interest and motivation in learning metrics.
    4. eliminating fears and misconceptions.
    5. identifying each student's motivation (or lack of).
    6. establishing reasonable goals for the students.

Don't try to force all students into becoming enthused. Learning metrication is not for everybody at this time. If you can get your students to take an open-minded look at both systems, the metric system will sell itself. Reviewing the history of the American system is amusing, relaxing, and informative.

The extent and depth of teaching will vary for each student or group of students, just as it does for any other subject. Much of the data needed for this decision can be drawn from the discussion.

2. *Create a Metric Curiosity.* Place metric measuring devices around the classroom and let interest generate on its own. For instance, you may hang a Celcius thermometer up, with the question, "Do you know the temperature today?" Leave the bathroom scales in the middle of the floor with a sign, "Do you know how little you weigh?" Or, tape two meter sticks to the wall and let the students measure their height. A student's natural curiosity can be tapped to make motivation easier. You may want to do this even before mentioning metrication. The student will become curious; then start the discussion casually.

   Materials: tape measures, meter
   sticks, bathroom scales, thermometer,
   index cards, masking tape,
   whatever metric materials you have.

3. *Hang up Metric Posters.* Students always stop to read a poster. Many commercial posters are quite amusing. Or, you can always make one of your own.

   Materials: posters or poster
   board and magic markers,
   a touch of creativity.

4. *Investigate Metrication in Business.* Encourage interested students to write familiar major manufacturers and retailers to find out what is being done in terms of conversion and implementation plans. This way the students will find out metrication's impact for themselves in concrete form. (It's also a good way to sneak in a gram of grammar and writing practice!).
5. *Field Trips and Resource People.* Another possibility is to go on a field trip or have a resource person visit from such places as hospitals, automobile companies, construction companies, schools, etc., where metrication is already affecting business.

Teaching Evaluation

If you have done your teaching well, your student should be able to:

1. Name at least three ways that metrication is already affecting our lives.
2. Explain at least two reasons for the switch to metrics in the U.S.
3. Determine what effect learning metrics will have on his life.

Resources: The Need for Metrics

American Metric Journal (bimonthly), AMJ Publication Co., Drawer L., Tarzana, California 91356.

Avertt, Dorothy M., and Bernice O. Crump, and Gerda I. Rosenbaum. Think Metric, New York: William H. Sadlier Inc., 1976. pp. 5-7.

Bitter, Gary G., Jerald L. Mikesell, and Kathryn Maurdeff. Activities Handbook for Teaching the Metric System, Boston: Allyn and Bacon Inc., 1976. pp. 5-8.

Buckeye, Donald. I'm O.K.-You're O.K., Let's Go Metric, Troy, Michigan: Midwest Publications, 1973. pp. 1-4.

Cunningham, James B. Teaching Metrics Simplified, Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1976. pp. 1-10,18.

Fugate, Sarah P., and Barbara H. LeGette. Listening Your Way to Understanding the Metric System, New York: Classroom World Productions, 1974. Lesson 6.

Gilbert, Thomas F., and Marilyn B. Gilbert. Thinking Metric, New York: John Wiley and Sons, Inc., 1973. pp. 1-5.

Introducing the Metric System (multi-media), Santa Monica, California: BFA Educational Media, 1972. Group 1.

Massey, Opal. Metrics for Home Use, Stockton, California: Willow House Publishers,1975. pp. 3-9.

A Metric America, 2nd edition. Glendale, California: Aims Instructional Media Services, 1975. Film.

Metric Education: A Position Paper for Vocational, Technical, and Adult Education. Columbus, Ohio: Center for Vocational Education, 1975. pp. 1-14.

Metric News (bimonthly), Rockford, Illinois: Key Markets Publication Co.

Odom, Jeffrey, Metric Measurement Kit. Columbus, Ohio: Xerox Education Publications, 1975. Volume 1, 6.

Ploutz, Paul F., The Metric System: A Programmed Approach. Columbus, Ohio: Charles E. Merrill Publiching Co., 1972. pp. 27-35.

Unit 2

Understanding Calibration

Unit Objectives:

The student should be able to:

1. Identify units on a scale.
2. Determine distance between marks on a scale.

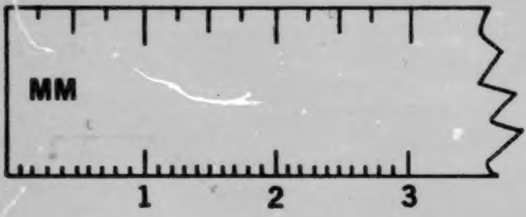
Before an adult can measure an object, he must be able to read and interpret the markings on his measuring tool. All too often it is assumed adults can do this without checking. Many ABE students, particularly in the lower levels, have not mastered this skill. It is therefore advisable to be certain that each student has mastered calibration before entering into any type of measurements, American or metric. This pretesting can be easily done during any regular math session. A question could be slipped in using a number line or such.

When teaching calibration, have students count the *spaces* rather than the line. Beginning students are often confused about which line is counted and why. The perceptive student will soon realize that the space ends with a line and he can count the end lines instead of the spaces.

It is not recommended that calibration be taught with a standard American ruler in the beginning. American rulers are marked with different length lines denoting halves, quarters, eights, etc.. Teach calibration with whole numbers first. Then after the student has mastered fractions, you may teach calibration on rulers with fractions.

Teaching Strategies

1. Identify the unit that is numbered on the scale. Sometimes the name of the unit is printed somewhere; sometimes not. Look for the labels.



The small lines are the millimeters. The labeled lines are centimeters. (1, 2, etc.)

Teacher's Note: Beware of rulers with American and metric units on each side. Some of these rulers number the centimeters but label the millimeters. These types can be very confusing to the adult learner.

2. Pick out the marks that are numbered.

3. Determine the distance between the two numbered marks by subtracting.

4. Count how many spaces there are between the numbered marks.

5. Divide the distance by the number of spaces. This will give you the value of each space.

6. You can now figure the value of any space on the scale by adding the value of the spaces to the starting number, see figure A for example.

    1. These are centimeters.
    2. The numbered marks are 10 and 18.
    3. The distance between them is 8.
    4. There are 4 spaces.
    5. By dividing, each space is worth 2.
    6. The number at the arrow must be 12cm.

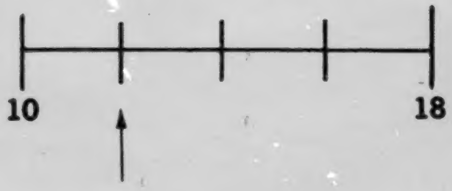


Figure A

Another example of determining calibration is shown in Figure B.

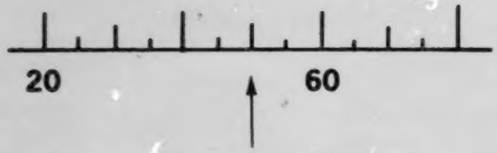


Figure B

1. The units are not labeled.
2. The numbered marks are 20 and 60.
3. The distance between them is 40. (60-20=40)
4. There are 8 spaces between the numbered marks.
5. By dividing, each space is worth 5. (40÷8=5)
6. The number at the arrow must be 50.
   (6 spaces X 5 spaces = 30)
   (20+30=50)

7. Make up a worksheet with just lines and numbers, as in the example. Go over the step by step process in detail with the student and then let him try some on his own.

   Materials: prepared examples on worksheets.

8. Give each student a piece of masking tape or a piece of cardboard. Ask each one to make it into a ruler, devising his own calibrations. Exchange the rulers and see if other students can determine the calibrations.

   Materials: masking tape or cardboard strips.

9. Bring in a varied assortment of measuring devises. Ask the students to determine the calibration of each.

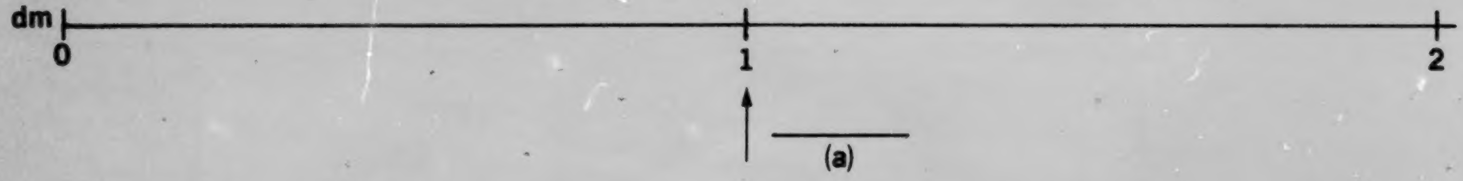
   Materials: measuring cups, rulers, scales, thermometers, measuring tapes, etc. Use as many practical, everyday items as possible.

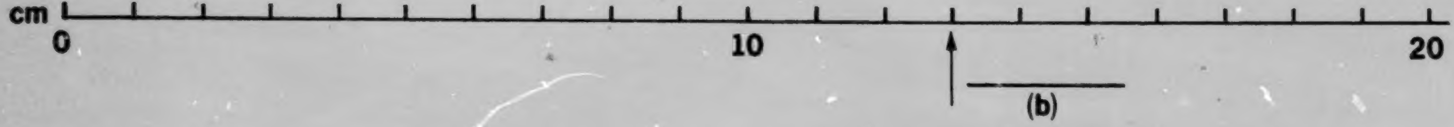
Teaching Evaluation

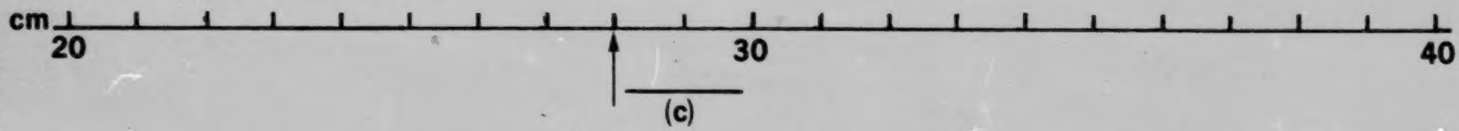
If you have done your teaching job well, your students will be able to:

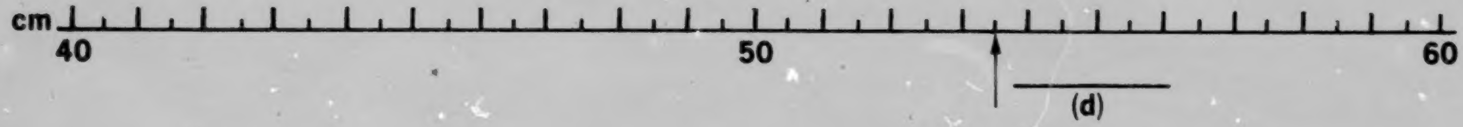
1. Identify the name of the unit when given a measuring device.
2. Accurately determine the value of any marking on a measuring device.

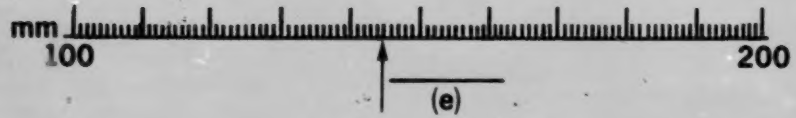
1. Write the value at each arrow. Be sure to label.











Do Your Answers Agree With These?

A) 10dm

B) 13cm

C) 28cm

D) 57cm

E) 145mm

Unit 3

The Decimal System

Unit Objectives:

The student should be able to:

1. Read decimal numbers.
2. Multiply and divide by multiples of 10.

Before venturing into metrics, it is advisable to review the decimal system, particularly place values. It is also advisable to review multiplication and division by multiples of 10. In doing so, the student will find learning metrication easier since the decimal system is the foundation of metrics. Also, metrication will not seem so foriegn to the student as he builds the relationship between decimals and metrics. Usually mastering metrics results in reinforcement and enrichment of the student's knowledge of decimals.

While many students are able to perform the four computations using decimals, some areas consistently create problems. To make mastering of metrics easier, each student should be able to:

1. *Read decimal numbers correctly.* Both students and teachers fall into the habit of saying, "one point six," instead of, "one and six tenths." The concept of a decimal is reinforced when it is read correctly.
2. *Know the difference a "th" makes at the end of a number.* Be sure your student can write numbers such as four hundred (400) and four hundredths (.04) correctly. Seeing the written words as well as hearing them will help.

3. *Add or remove a decimal point and/or zeros as necessary.* Relating this to money may simplify the problem. For instance:

Example 1. Adding Zeros.

.3 = 3 tenths or 3 dimes
.30= 30 hundredths or
30 cents, yet both have
the same value. So,
.3 = .30

Example 2. Locating the decimal point.

$25 represents an unseen decimal point at the end of a number; specifically, $25.00.

In each above case, nothing has happened to the value of the number; it has merely been renamed.

4. *Write decimal numbers in order from smallest to largest and vice versa.* This is another method of reinforcing the concept of renaming decimals. One method of teaching this involves three steps. (see example below)

A) Write the numbers in a column, lining up the decimals points.
B) Fill in with zeros until all numbers have the same number of decimal places.
C) Now you can arrange the numbers in order.

Example 1. Arrange these numbers in order of the smallest to the largest:

.206, 2.6, .26, .026

Step One

Write the numbers in a column, lining up the decimal points.

```
 .206
2.6
 .26
 .026
```

Step Two

Fill in with zeros until all the numbers have the same number of decimal places.

0.206
2.600
0.260
0.026

Step Three

Rearrange the numbers in order. You may drop the extra zeros now.

	or	
0.026		.026
0.206		.206
0.260		.26
2.600		2.6

Finally it is important that the student be comfortable with the shortcut method of multiplying and dividing by multiples of 10. Knowing this method will make conversion of measurements much simpler.

To multiply a number by a power of 10, move the decimal point to the right as many places as there are zeros in the power. For example, to multiply by 10, since there is one zero, move the decimal point one place to the right. To multiply by 100, since there are two zeros, move the decimal point two places to the right. Annex zeros as needed.

.38 X 10 = 3.8	.38 X 100 = 38
3.8 X 10 = 38	3.8 X 100 = 380
38 X 10 = 380	38 X 100 = 3800

To divide a number by a power of 10, move the decimal point to the left as many places as there are zeros in the power.

.38 ÷ 10 = .038	.38 ÷ 100 = .0038
3.8 ÷ 10 = .38	3.8 ÷ 100 = .038
38 ÷ 10 = 3.8	38 ÷ 100 = .38

Be sure students don't fall into any of the common *traps* of confusion:

1. *Where is the decimal point when you don't see it?* Like a forgotten period at the end of a sentence, unseen decimal points belong at the right end of a number. ($5 = $5.00)
2. *Which way do you move the decimal point?* Remember, when multiplying by a whole number, your answer will be larger. You can get a larger number by moving the decimal point to the right. Dividing by a whole number results in a smaller number, so move the decimal point to the left when dividing.
3. *When do you add zeros?* Add zeros only if there are no other numbers to move the decimal point around.

   3.8 ÷ 100 = .038

   .26 X 1000 = .260 X 1000 = 260

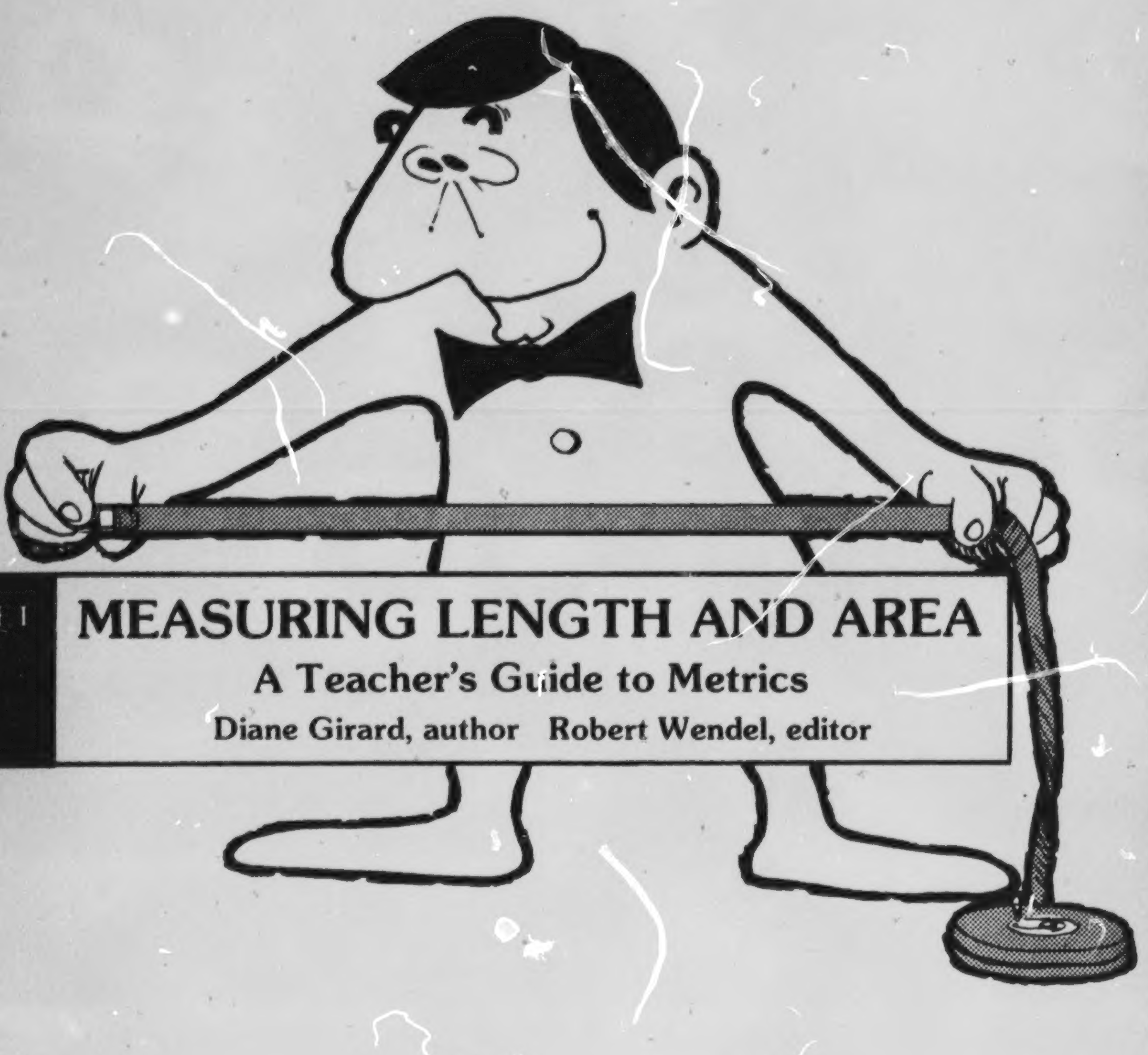
Teaching Strategies

In addition to what is printed above, both concept and computations of decimals are thoroughly covered in ABE math books. A combination of those materials, discussions, and supplementary written exercises as needed should be sufficient.

Teaching Evaluation

If you have done your teaching job well, your student's should be able to:

1. Read and write decimal numbers in both words and numbers.



BOOKLET
3

MEASURING LENGTH AND AREA

A Teacher's Guide to Metrics

Diane Girard, author Robert Wendel, editor

2. Recognize that extra zeros after a decimal number do not affect the value of the decimal.
3. List a series of decimal numbers in ascending or descending order.
4. Use the shortcut method of multiplying and dividing by multiples of 10.

Sample Written Exercises

1. Write the following in numbers:

   a. six tenths ______________________

   b. six hundredths ______________________

   c. six thousandths ______________________

   d. seventy-eight hundredths ____________

   e. three thousand, sixty-two and fifty-nine hundredths

   ____

   f. four hundred thirty-one and seven thousandths

   ____

   g. nine and five hundred fifty-four thousandths

   ____

2. Circle the letter of the correct way to read 4509.072 in words:

   a. four hundred fifty-nine and seventy-two thousandths

   b. four thousand five hundred ninety and seventy-two thousandths

   c. four thousand five hundred nine and seventy-two thousandths

   d. four hundred fifty-nine and seventy-two hundredths

3. Circle the letter of the correct way to read .068 in words:

   a. sixty eight hundredths

   b. sixty eight thousand

   c. sixty eight thousandths

   d. sixty eight hundred

4. Circle the two numbers in each line that have the same value.

a. 0.45 0.405 0.450 0.045

b. 8.064 8.64 8.604 8.640

c. 0.003 0.0003 0.300 0.3

5. Write these numbers in order from smallest value to the largest.

4.7 .47 .047 .407 4.07

_____ _____ _____ _____ _____

6. Write these numbers in order from the largest value to the smallest.

.0039 .39 .039 3.9 3.009

_____ _____ _____ _____ _____

7. If you used the short-cut method to multiply .539 X 100, you would:

a. move the decimal point 2 places to the left.

b. move the decimal point 2 places to the right.

c. move the decimal point 3 places to the left.

d. move the decimal point 3 places to the right.

8. If you used the short-cut method to divide 82.634 ÷ 1000, you would:

a. move the decimal point 2 places to the left.

b. move the decimal point 2 places to the right.

c. move the decimal point 3 places to the left.

d. move the decimal point 3 places to the right.

Do Your Answers Agree With These?

1. A) .6
   B) .06
   C) .006
   D) .78
   E) 3062.59
   F) 431.007
   G) 9.554

2. C

3. C

4. A) 0.45 0.450
   B) 8.64 8.640
   C) 0.300 0.3

5. .047 .407 .47 4.07 4.7

6. 3.9 3.009 .39 .039 .0039

7. B

8. C

Unit 4

Understanding Prefixes

Unit Objectives:

The student should be able to:

1. List the six everyday prefixes in order.
2. Write the numerical meaning of each prefix.
3. Write the correct symbol for each prefix.
4. Interpret the meaning of a unit based on its prefix.

If, during the course of instruction, you are already teaching prefixes, roots, and suffixes in English, then your student may find little trouble in adopting the metric prefixes. If not, some comparison to other familiar prefixes will probably put them at ease.

The simplicity of the metric system is apparent from the use of the multiples and subdivisions of the base unit. Remember, this measuring system is based on the decimal system so all units are multiples of the number 10.

Regardless of the name of the base unit, the same prefixes may be annexed to it. A kilometer equals 1000 meters; a kiloliter equals 1000 liters; a kilogram equals 1000 grams. Also, if the base unit were a meter, adding prefixes gives you kilometer for measuring long distances.

KILOMETER
KILOLITER = 1000 LITERS
KILOGRAM

METERS
GRAMS

Figure [illegible]

Prefix	Symbol	Numerical Meaning
kilo-	k	1000 basic units
hecto-	h	100 basic units
deka-	dk*	10 basic units
-----	-	1 basic unit
deci-	d	0.1 of a basic unit
centi-	c	0.01 of a basic unit
milli-	m	0.001 of a basic unit

Metric prefixes are described in the above chart. After examining the chart, note the following points:

1. The small letters represent metric units and prefixes and symbols, not abbreviations, and therefore are not followed by a period.
2. Prefixes are never used alone in metrics with the exception of "kilo", a common term for kilogram, as in a kilo of drugs.
3. There are both larger and smaller prefixes existing, but they will not be common in everyday usage. Briefly, they are as follows:

Prefix	Symbol	Numerical Meaning
mega-	M	one million (1,000,000)
	Example. One megagram (1Mg equals 1,000,000 grams.	
micro-	μ	$\frac{1}{1,000,000}$
	Example. One micrometer (1 m) is $\frac{1}{1,000,000}$ of a meter.	

* While "da" is the international symbol, common American usage is "dk".

4. Do not create a new prefix by combining two prefixes. For example, one tenth of a hundredth of a meter is a millimeter, not a deci-centimeter. The correct prefix already exists, so why not use it.
5. Attention should be given to adherence to symbols, definitions, and spelling as defined by the International System of Unit (SI). Some products being manufactured in the U.S. do not carry the proper symbols or spellings. Improper symbols or spellings will only add to the student's confusion.

When teaching prefixes, it is important that students know the names and values in order. A number of teachers have preferred to present the prefixes horizontally rather than vertically. This horizontal presentation is seen in Figure 2 below.

Prefix	kilo	hecto	deka		deci	centi	milli
Symbol	k	h	dk		d	c	m
Number	1000	100	10	1	.1	.01	.001
Meaning	Thousands	Hundreds	Tens	Ones	Tenths	Hundredths	Thousandths

This method helps the student see the relationship to the decimal system since the prefixes are superimposed on the place values of the decimal system. Notice the fractional prefixes all end in "i".

Teaching Strategies

1. As part of word attack skills, teach the prefixes and their meanings before even delving into metrics.
2. Teach the six prefixes together, in order. Try to relate the prefixes to better known uses.

   Example. deci - decimal point starts the tenths.
   centi - 100 cents in a dollar.
   milli - a tax mill is 0.1 of a penny or .001 of a dollar.
   deka - a decade is 10 years.
3. Make a chart out of poster board displaying it prominently in the room. (Or have a student do so.) Students may remember just by seeing it so often. Suggested types of charts are included in this manual.
4. A different approach is to start with measuring distance with a meter stick. Then use the centimeter and finally the millimeter calibration. Eventually you should introduce all six prefixes. This method helps define the concept of the prefixes in terms of visable images. You need a meter stick with centimeter and millimeter markings.

Teacher's Note: Although prefixes have been treated as a separate unit in this guide, they do not necessarily have to be taught separately. In fact, one successful method is a combination of activities one and three. Start with the meter; discover the relationship of the centimeter and then the millimeter. Eventually, you will cover all of the common prefixes. Then review the prefixes as a group.

Whatever method you choose, remember that the student's competence and self confidence in prefixes will increase as these concepts are reinforced through application in length, volume, and weight. Prefixes are not used alone in metrics.

Teaching Evaluation

If you have done your teaching job well, your student should be able to:

1. List the six common prefixes in order.
2. Write the numerical value of each prefix.
3. Determine the value of an imaginary number by its prefix. For instance, a deciquiggle is .1 of a quiggle.
4. Write the symbol for each prefix.
5. Create his own measuring system by combining the prefixes with an imaginary measurement, and then give the value of each unit.

Sample Written Exercises

1. Write the six common prefixes in order, from the largest value to the smallest.

______ ______ ______ X ______ ______ ______

2. Write the letter of the numerical value that matches its prefix.

_____centi-	a) .1
_____hecto-	b) 1000
_____milli-	c) .001
_____deka-	d) 100
_____kilo-	e) 10
_____deci-	f) .01

3. Write the symbol for each of the following prefixes.

deci-_________ kilo-_________ milli-_________

hecto-_________ centi-_________ deka-_________

4. A centispark =

a. 10 sparks c. 100 sparks

b. .1 sparks d. .01 sparks

5. A hectosplick =

a. 10 splicks c. .1 splicks

b. 100 splicks d. .01 splicks

6. A millipam =

A) 100 pams
B) 1000 pams
C) .01 pams
D) .001 pams

7. Finish the names of this imaginary measuring system, then write the value of each on the second line.

Name: _____ _____ _____ tub _____ _____ _____

Value: _____ _____ _____ 1 _____ _____ _____

Do Your Answers Agree With These?

1. kilo hecto deka deci centi milli

2. F
   D
   C
   E
   B
   A

3. d k m
   h c dk

4. D

5. B

6. D

7. kilotub hectotub dekatub tub decitub centitub millitub
   1000tubs 100 tubs 10 tubs 1 tub .1 tub .01 tub .001 tub

Resources: Common Metric Prefixes

Bitter, Gary G., Jerald L. Mikesell, and Kathryn Maurdeff. *Activities Handbook for Teaching the Metric System*, Boston: Allyn and Bacon, Inc., 1976. pp. 21-26.

Fugate, Sarah P., and Barbara H. LeGette. *Listening Your Way to Understanding the Metric System*, New York: Classroom World Productions, 1974. Lesson 1.

Gilbert, Thomas F., and Marilyn B. Gilbert. *Thinking Metric*, New York: John Wiley and Sons, Inc., 1973. pp. 6-17.

Hartsuch, Paul J. *Think Metric Now!* Chicago: Follett Publishing Co., 1974. pp. 9, 61.

Massey, Opal. *Metrics for Home Use*, Stockton, California: Willow House Publishers, 1975. pp. 10-11.

Metric Education: A Position Paper for Vocational, Technical, and Adult Education, Columbus, Ohio: Center for Vocational Education, 1975. pp. 10.

Metric System Skills (recordings), Freeport, New York: Educational Activities Inc., 1973. AR720.

The Metric System - What It Is and How to Use It, New York: Preston Publication Co., Inc., 1975. pp. 12-17.

Rabenau, Diane F., *The Metric System*, Salem, Ohio: MacMillan Media Associates, 1974. pp. 2, 8, 9.

Sorenson, Juanita S., *Measuring In Metric*, Eau Claire, Wisconsin: Pencraft, 1975. pp. 19-36

Wallace, Jesse D., *The Metric Pal*, Chico, California: Jesse D. Wallace. 1976. p. 26.

A TEACHER'S GUIDE TO METRICS

A Series of In-Service
Booklets Designed for
Adult Educators

Booklets in This Series

Booklet One:	Before You Begin Teaching Metrics
Booklet Two:	Metric Readiness
Booklet Three:	Measuring Length and Area
Booklet Four:	Measuring Volume
Booklet Five:	Measuring Weight
Booklet Six:	Determining Temperature
Booklet Seven:	Conversion Between Metric Units

This guide was developed pursuant to project No. 018A76SD with the Division of Federal Assistance, Ohio Dept. of Education. The activity which is the subject of this report was supported in whole and in part by the U.S. Office of Education, Department of Health, Education, and Welfare. However, opinions expressed herein do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

Diane Girard, Dayton Public Schools

Robert Wendel, Miami University

Co-Directors

Measuring Length and Area

Booklet Three

Unit Page

1. Measuring Length.......................... 1
2. Determining Area........................... 16

Unit 1

Measuring Length

Unit Objectives:

The student should be able to:

1. Write the seven common length measurements and their correct symbols in order.
2. Identify a unit upon seeing its length.
3. Estimate the length of an item.
4. Measure the length of an item accurately.
5. Tell the length of his hand span and his height.

The basic unit for measuring length is the meter. A meter is slightly longer than a yard.

Multiples and subdivisions are formed by adding the prefixes as shown in Figure 1 below:

Name	Symbol	Value
kilometer	km	1000 meters
hectometer	hm	100 meters
dekameter	dkm	10 meters
meter	m	1 meter
decimeter	dm	.1 meters
centimeter	cm	.01 meters
millimeter	mm	.001 meters

Notice that each unit name is made of two parts. The root (meter) is the base unit and identifies the type of measurement (length).

The prefix tells the size of the unit, as in this chart.

NAME	ROOT	UNIT	VALUE
kilometer =	kilo +	meter =	1000 m
millimeter =	milli +	meter =	.001 m

The symbols are a combination of the prefix symbol and the symbol for the unit.

NAME	ROOT	UNIT SYMBOL	SYMBOL
kilometer =	kilo + (k) +	meter (m) =	km
millimeter =	milli + (m) +	meter (m) =	mm

In each type of measurement, certain sizes will be used more often than the others. In length, the most common are the kilometer, meter, centimeter, and millimeter.

It must be emphasized that one of the most effective approaches appears to be a "hands on" approach. Rather than talk about abstract units and prefixes, show the measurement.

The sooner the student identifies the measurement himself, the quicker he will become comfortable with metrics.

An effective teaching method is comprised of three steps:

1. *Conceptualizing*. The student, as a result of different activities, develops a concept of the value of each unit.
2. *Estimating*. The student then applies his concept by estimating a variety of items.
3. *Measuring*. Finally, actual measurement reinforces the student's estimations. This should follow the estimation of each object as soon as possible for optimum results.

The teacher should be aware of two facets of this technique. Firstly, this approach is highly activity-oriented. Some preparation time is needed for organizing the objects to be measured, the tools needed, and the method of giving instructions.

Secondly, this is essentially a discovery approach. The teacher must refrain from dominating all discussions and performing the activities himself. Experience has shown that ABE students find this approach a welcome alternative to more traditional methods.

Teaching Strategies

Start out measuring distances using a meter stick. Students can share meter sticks and tapes. Any distance formerly measured in yards can now be measured in meters. When the students are measuring, encourage them to use a five step process.

A) Guess. (alone as an individual)
B) Record the guess on a sheet of paper.
C) Actually measure.
D) Record the actual measurement making sure the measurement has a unit written after the number:
Right: 5m Wrong: 5
E) Compare the guess with the actual measurement.

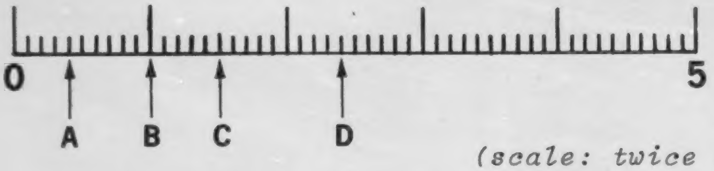
Next, progress to the centimeter. It will be used for most everyday measurements, such as height, waist, paper sizes, etc. Using a meter stick numbered in centimeters will reinforce the equivalence that 100 centimeters equals one meter. Now have the students measure items; a 20 or 25 centimeter ruler is sufficient. Make sure each student has access to a ruler.

If your resources are limited, two alternatives are available. Pick up some inexpensive lumber scraps and make rulers. It doesn't take long to do this. You may lose a little accuracy in this process, however. Or, take a look at your 12 inch ruler and see if it doesn't have centimeters on the bottom side. Just be sure that the students ignore the inch side; some masking tape covering those numbers might help.

Some alert student is bound to ask about the tiny spaces. This will present the opportunity for the student to discover and/or reinforce the logic of the metric system. Have the students count how many tiny spaces there are in a centimeter. Since there are 10 tiny spaces in each centimeter and 100 centimeters in a meter, then there must be 1000 tiny spaces or millimeters in a meter. The same logic can be applied to discover the other units.

Make sure the students receive enough practice in measuring some items in centimeters and some in millimeters.

At this point, you might ask the student to measure the same item in centimeter, then millimeters. A practice sheet with the following exercise might help:



(scale: twice actual size)

Point A = .4cm or 4mm

Point B = 1cm or 10mm

Point C = 1.5cm or 15mm

Point D = 2.4cm or 24mm

Such exercises can also be adapted for other measurements.

You may also want to make two overhead transparencies. On one, mark the length only in centimeters; on the other, mark the same length only in millimeters. Show each; then place one over the other. Use the two masters on the next pages to make transparencies.

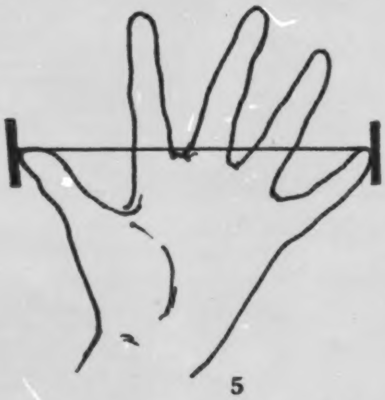
Remember that the primary function is measurement. Changing from one metric unit to another metric unit should be based on reading measurements. Save mathematical conversion rules for later; those tend to scare and confuse many students if presented prematurely. AVOID CONVERSIONS!

Long measurements, particularly the kilometer, are difficult in the ABE classroom. Compare and discuss well known distances in terms of kilometers and miles. Each student should have a map of Ohio for this exercise. A measurement of a long hallway might help clarify the concept also. Make use of any outdoor activity available at your location. Again, guess, then measure.

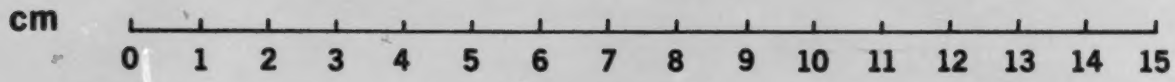
Teaching Evaluation

If you have done your teaching job well, your students will be able to:

1. Estimate and measure the length and width of a book accurately.
2. Tell his height metrically.
3. State the length of his span metrically. (The span is the distance from the tip of the thumb to the small finger of a spread hand.)



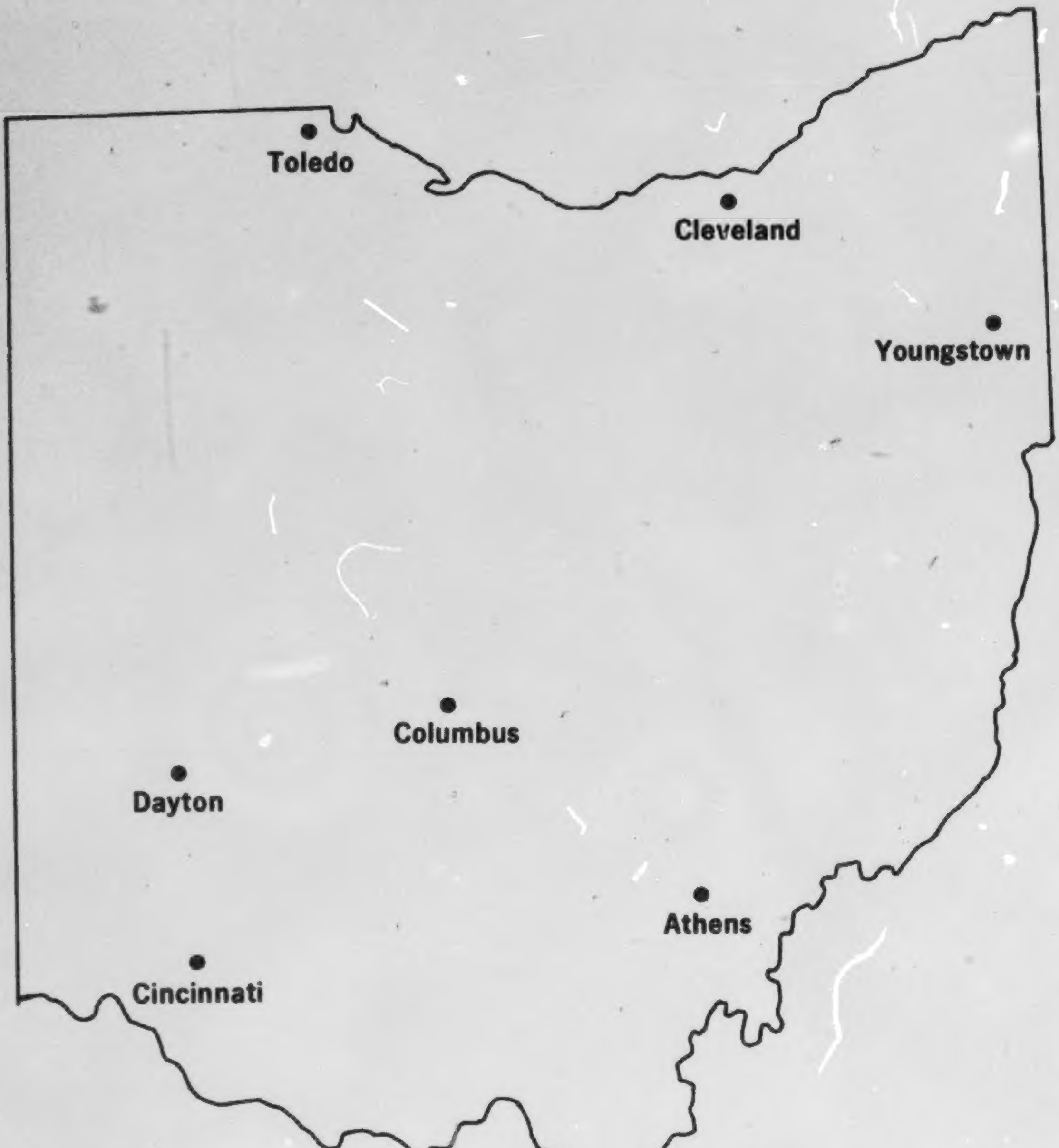
4. Measure his waist accurately.
5. Estimate the distance metrically from his home to the ABE center.
6. Identify the proper unit he would use in measuring the length of the classroom, a pencil, a car, a fingernail, and the distance to another city.
7. Write all seven common length measurements and their symbols in order.

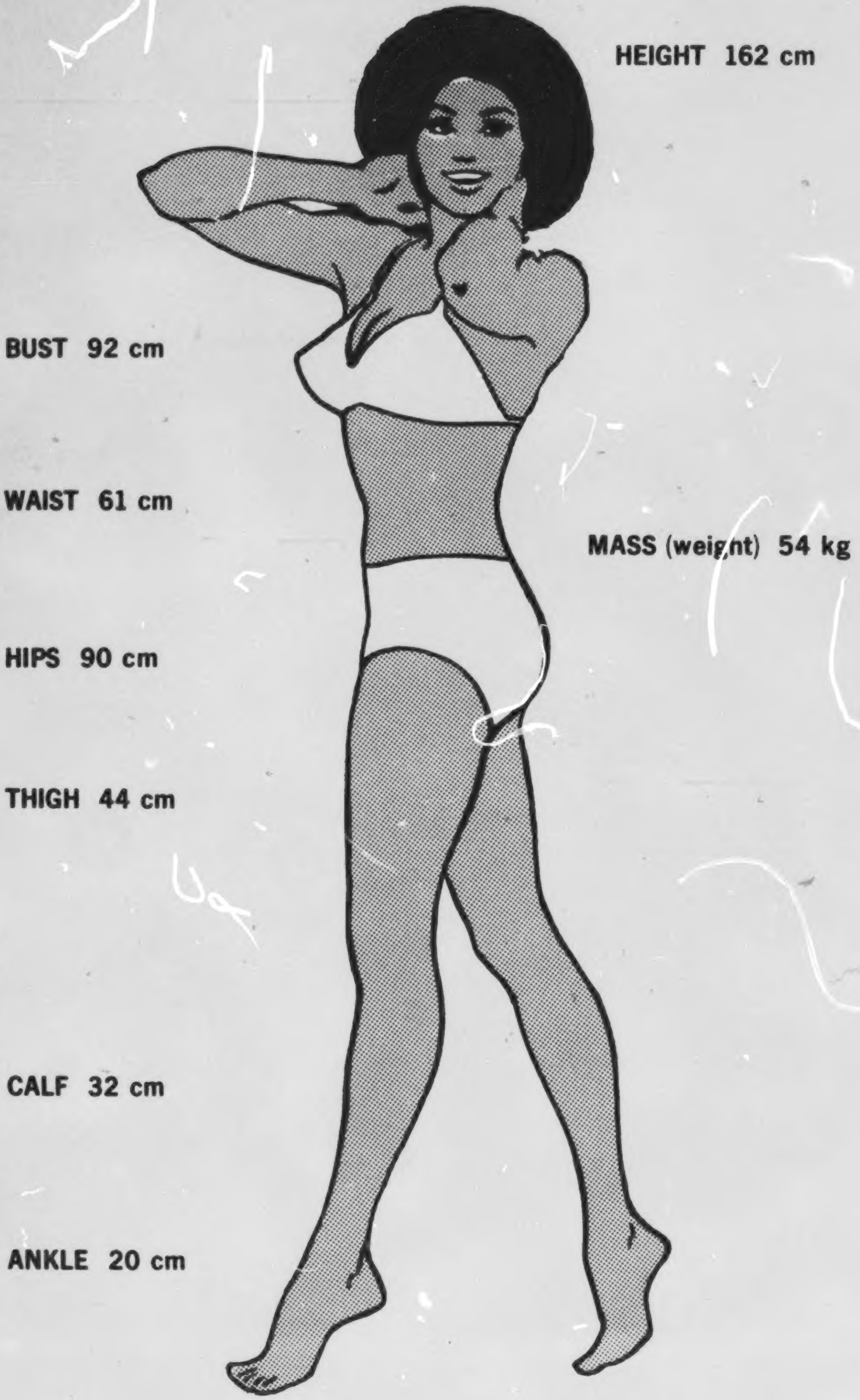

cm

mm
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

63

64


Toledo
Cleveland
Youngstown
Columbus
Dayton
Athens
Cincinnati


HEIGHT 162 cm
BUST 92 cm
WAIST 61 cm
MASS (weight) 54 kg
HIPS 90 cm
THIGH 44 cm
CALF 32 cm
ANKLE 20 cm

Sample Written Exercises

1. An adult woman might have a height of which of the following?
    - a. 1 meter
    - b. 150 centimeters
    - c. 250 centimeters
    - d. 3 meters

2. An adult's span (widest spread of the hand) might be:
    - a. 50 centimeters
    - b. 20 millimeters
    - c. 20 centimeters
    - d. 50 millimeters

3. A kilometer is about:
    - a. the length of this paper.
    - b. the heigth of a standard door.
    - c. the length of a standard school room.
    - d. half a mile.

4. The length of a pencil would probably be about:
    - a. 20 millimeters
    - b. 20 kilometers
    - c. 20 meters
    - d. 20 centimeters

5. The width of your thumb is probably about:
    - a. 20 millimeters
    - b. 20 meters
    - c. 20 centimeters
    - d. 20 kilometers

6. The distance from Dayton to Columbus is about:

   a. 75 meters
   b. 100 kilometers
   c. 60 hectometers
   d. 80 dekameters

7. Which would be the most appropriate unit for measuring the width of a car?

   a. millimeter
   b. kilometer
   c. centimeter
   d. meter

8. Write the symbols of the seven units commonly used to measure length starting with the largest.

   ______ ______ ______ ______ ______ ______ ______

9. 3.36 meters could be also written as:

   a. 33.6dkm
   b. .336cm
   c. 336cm
   d. 33.6mm

10. 42.68km could also be written as:

   a. 426.8m
   b. 4268m
   c. 42,680
   d. .4268m

Do Your Answers Agree With These?

1. C

2. C

3. D

4. D

5. A

6. B

7. D

8. km, hm, dkm, m, dm, cm, mm

9. C

10. C

Resources: Linear Measurement

Averett, Dorothy M., and Bernice O. Crump, and Gerda I. Rosenbaum. *Think Metric*, New York: William H. Sadlier, Inc., 1976. pp. 8-19.

Bitter, Gary G., and Jerald L. Mikesell, and Kathryn Maurdeff. *Activities Handbook for Teaching the Metric System*, Boston: Allyn and Bacon, Inc., 1976. pp. 33-93.

Buckeye, Donald. *I'm O.K. You're O.K., Let's Go Metric*, Troy, Michigan: Midwest Publications, 1975. pp. 1-21.

Buckeye, Donald. *Introducing the Metric System With Activities*, Troy, Michigan: Midwest Publications, 1972. pp. 1-8.

Clack, Alice A. and Carol H. Leitch. *Amusements in Developing Metric Skills*, Troy, Michigan: Midwest Publications, 1973. pp. 9-21.

Cunningham, James B. *Teaching Metrics Simplified*,Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1976. pp. 59-68.

Fugate, Sarah P.,and Barbara H. LeCette. *Listening Your Way to Understanding the Metric System*,New York: Classroom World Productions, 1974. Lesson 2.

Gilbert, Thomas F., and Marilyn B. Gilbert. *Thinking Metric*, New York: John Wiley and Sons, Inc., 1973. pp. 18-42.

Hartsuch, Paul J. *Think Metric Now!* Chicago: Follett Publishing Co., 1974. pp. 13-23.

Hoffman, Sylvia A. *Metrication Masters*, New York: Holt, Rinehart, and Winston, Inc., 1974.

Introducing the Metric System, Santa Monica, California: BFA Educational Media, 1972. Group 2. (multimedia).

Let's Measure Metric, Columbus, Ohio: Ohio Dept. of Education, 1975. pp. 7-12.

Massey, Opal. *Metrics for Home Use*, Stockton, California: Willow House Publishers, 1975. pp. 19-22.

The Metric System, Menlo Park, California: Addison-Wesley Publishing Co., 1974. pp. 2-30.

Resources: Linear Measurement (cont')

Metric System Skills, Freeport, New York: Educational Activities, Inc., 1973. AR721. (recording).

The Metric System - What It Is and How to Use It,New York: Preston Publishing Co. Inc., 1975. pp. 19-22.

Miller, Mary R., and Toni C. Richardson. Making Metric Manuevers, Hayward, California: Activity Resource Co., 1974. pp. 1-33.

Odom, Jeffrey. Metric Measurement Kit, Columbus, Ohio: Xerox Education Publications, 1975. Volume 2. (multimedia).

Ploutz, Paul F. The Metric System: A Programmed Approach, Columbus, Ohio: Charles E. Merrill Publishing Co., 1972. pp. 56-65.

Rabenau, Diane F. The Metric System, Salem, Ohio: MacMillan Media Associates, 1974. pp. 10-12.

Rahn, Joan Elma. The Metric System, New York: Atheneum, 1976. pp. 22-32.

Sorenson, Juanita S. Measuring In Metric, Eau Claire, Wisconsin: Pencraft, 1975. pp. 19-36.

Think Metric - Understanding and Using the Metric System, Chicago:Denoyer-Geppert Audio-Visuals, 1973. Group 3, 4. (slides)

Wallace, Jesse D. The Metric Pal, Chico, California: Jesse D. Wallace, 1976. pp. 4-10.

Witte, Carol, and Betty Long. Fun With Metric Measurement, Manhatten Beach, California: Teachers, 1973. pp. 1-53.

Unit 2

Determining Area

Unit Objectives:

The student should be able to:

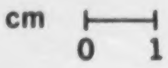
1. Estimate the area of a given item.
2. Measure the area of a given region accurately.

The difficulty in teaching area lies not with metrics, but with the concept of area. This unit may not be appropriate for some of your ABE students depending on their progress in math. For those learning this unit, direct experience with measurement is once again vital.

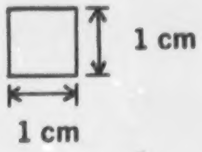
An area is a measurement of a surface. It can be determined either by counting the number of standard units it takes to cover the surface, or if the surface is a standard shape it can be calculated from the linear measurements of the surface. For example, if the surface is rectangular, the area of the surface can be calculated by multiplying the length and width of the surface.

To indicate area, the word "square" precedes the unit. A raised "2", an exponent, also indicates "square". Look at these examples:

Example 1: This line is one cm long (1cm).

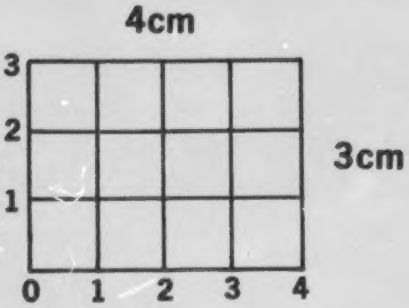


Example 2: This is one square centimeter.



It is written 1cm^2.

Example 3: Find the surface area of this diagram.



Solution: $4cm \times 3cm = 12cm^2$.
The answer $12cm^2$, can be read as
"twelve centimeters squared" or
" twelve square centimeters".

Teaching Strategies

For practice, give the students a transparent grid of square centimeters. (These grids may be made from the master included in this unit.) Ask the students to estimate, then measure tha area of some objects. Finally, they may calculate the area mathematically.

Apply the concept of area to meters. Draw a square meter on the chalkboard or cut a solid one from cardboard. Measure the floorspace of a classroom if possible. Relate the activity to a practical problem such as determining the amount of tile or carpeting or varnish needed to cover the floor. Don't be surprised if some students have difficulty; relatively few ABE students can figure square meters on sight.

An ABE student should know how to estimate and measure these surfaces in the metric system: square meter (m^2), square centimeter (cm^2), and square millimeter (mm^2). It would be impossible to expect students to measure square kilometers (km^2).

There is a set of measurements in metrics that deal specifically with area. The basic unit of area is the "are" (rhymes with dare). It is equal to a square, 10 meters long on each side or 100 square meters. The prefixes can also be affixed to the "are". Most common is the hectare, or 100 ares. However, the "are" and hectare are so large that they are mostly used in land measurement. Therefore, the likelihood that an ABE student would need them is relatively slim.

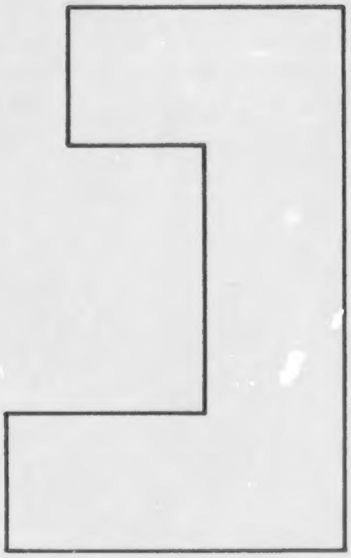
Many metric textbooks contain exercises relating to computing the area of rectangles, circles, and triangles. If a student has not encountered those in regular math, wait until he has mastered those concepts before applying them to metrics.

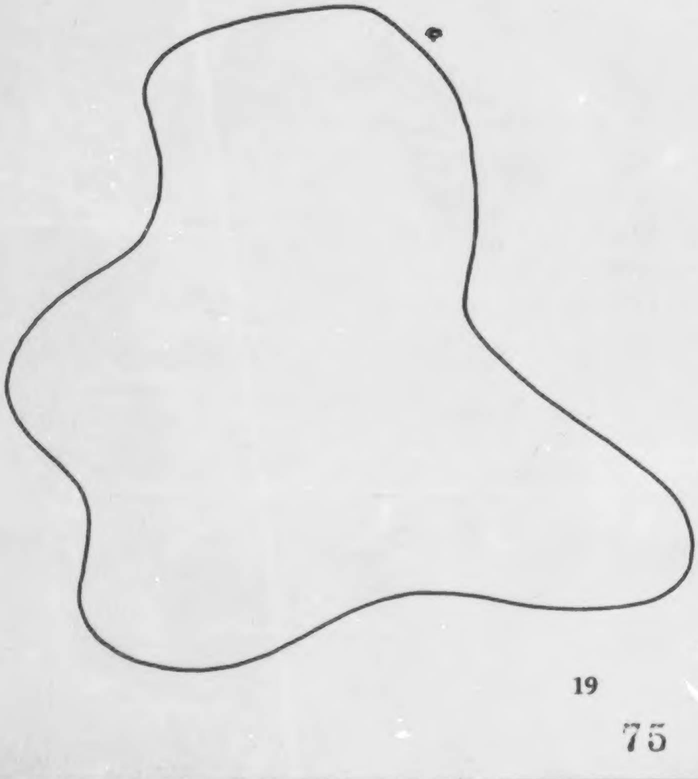
Teaching Evaluation

If you have done your teaching job well, your students will be able to:

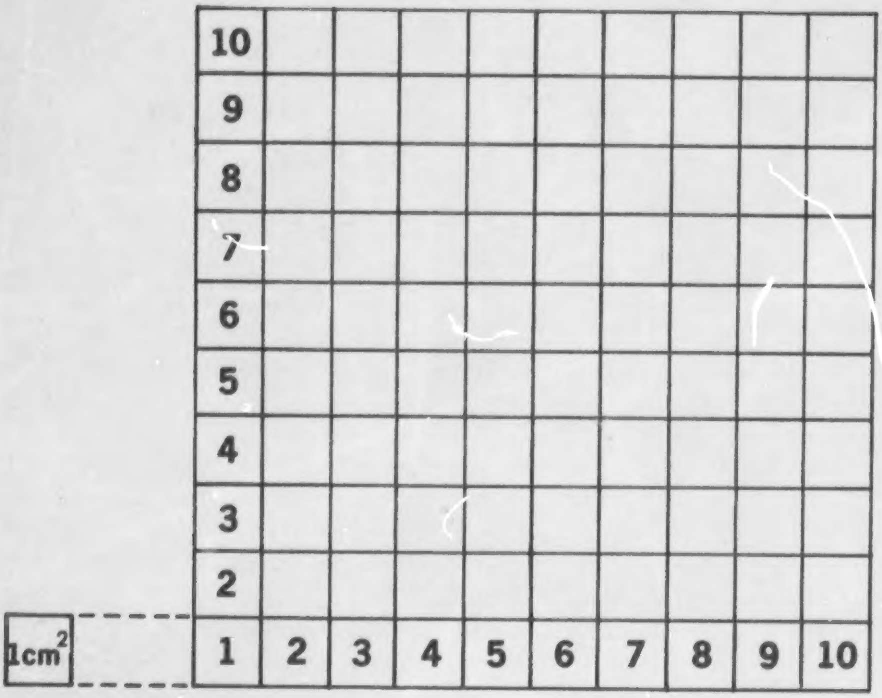
1. Estimate the area of both regular and irregular shapes.
2. Measure the area of both regular and irregular shapes.

Examples of such shapes are given on the next page.





1 dm^2

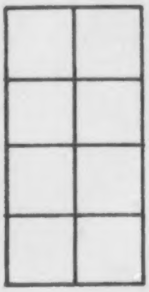

10
9
8
7
6
5
4
3
2
1cm^2
1
2
3
4
5
6
7
8
9
10

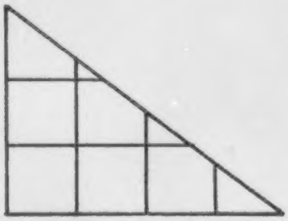
Sample Written Exercises

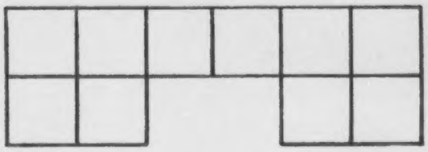
1. What do you estimate is the area of this sheet of paper?

____

2. Figure the areas of these figures: (Don't forget a label)

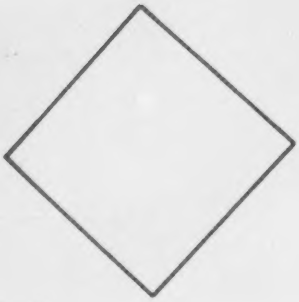


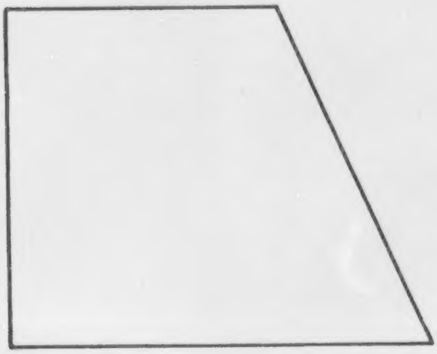


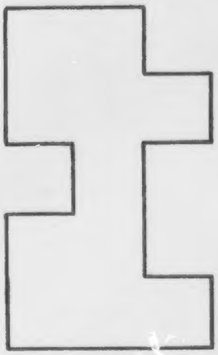


(a) ____________________ (b) ____________________ (c) ____________________

3. Measure to find the area of these figures: (Don't forget a label)

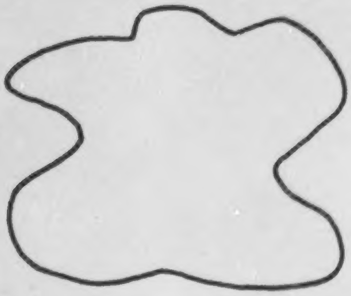






(a) ____________________ (b) ____________________ (c) ____________________

4. What do you estimate is the area of this:



____

Do Your Answers Agree With These?

1. Approximately 20cm by 30cm or 600cm^2.
   (Answers should be in this neighborhood.)

2. A) 8cm
   B) 6cm
   C) 10cm

3. A) 9cm
   B) 25.5cm
   C) 11cm

4. Approximately 13.75cm.

Resources: Area Measurement

Averett, Dorothy M., Bernice O, Crump, and Gerda I. Rosenbaum. Think Metric, New York: William H. Sadlier, Inc., 1976. pp. 20-27.

Bitter, Gary G., Jerald L. Mikesell, and Kathryn Maurdeff. Activities Handbook for Teaching the Metric System, Boston: Allyn and Bacon, Inc., 1976. pp. 94-142.

Buckeye, Donald. I'm O.K. You're O.K., Let's Go Metric, Troy, Michigan: Midwest Publications, 1973. pp. 22-34.

Buckeye, Donald. Introducing the Metric System With Activities, Troy, Michigan: Midwest Publications, 1972. pp. 9-14.

Clack, Alice A. and Carol H. Leitch. Amusements in Developing Metric Skills, Troy, Michigan: Midwest Publications, 1973. pp. 9-21.

Fugate, Sarah P. and Barbara H. LeGette. Listening Your Way to Understanding the Metric System, New York: Classroom World Productions, 1974. Lesson 3.

Hartsuch, Paul J. Think Metric Now! Chicago: Follett Publishing Co., 1974. pp. 24-33.

Let's Measure Metric, Columbus, Ohio: Ohio Dept. of Education, 1975. pp. 13-18.

Massey, Opal. Metrics for Home Use, Stockton, California: Willow House Publishers, 1975. p. 23.

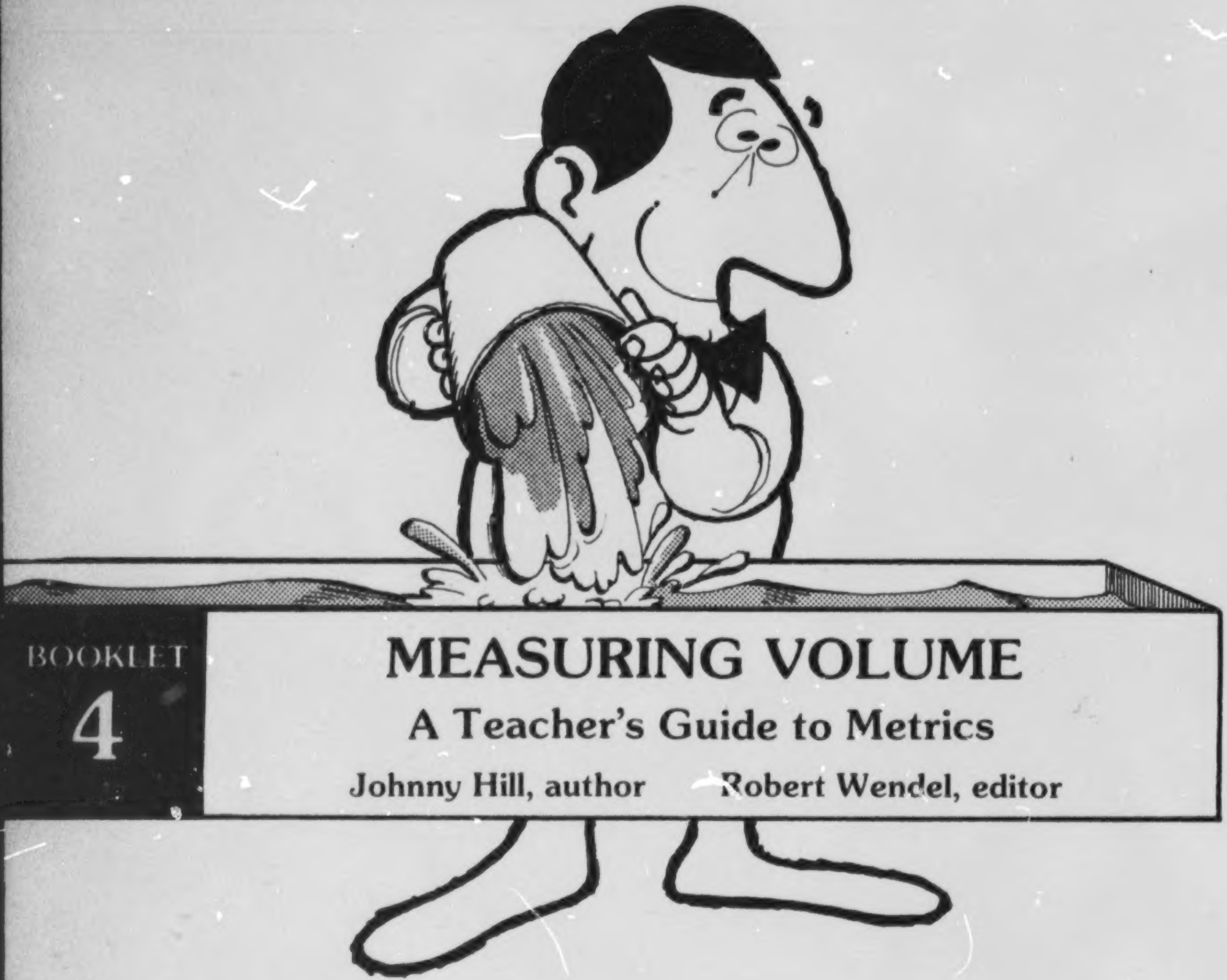
The Metric System, Menlo Park, California: Addison-Wesley Publishing Co., 1974. pp. 31-41.

The Metric System - What It Is and How to Use It, New York: Preston Publushing Co., Inc., 1975. pp. 23-25.

Miller, Mary R. and Toni C. Richardson. Making Metric Manuevers, Haywood, California: Activity Resource Co., 1974. pp. 35-53

Rahn, Joan Elma. The Metric System, New York: Atheneum, 1976. pp. 33-38.

Think Metric - Understanding and Using the Metric System, Chicago: Denoyer-Geppert Audia-Visuals, 1973. Group 6. (slides).



BOOKLET 4

MEASURING VOLUME

A Teacher's Guide to Metrics

Johnny Hill, author Robert Wendel, editor

A TEACHER'S GUIDE TO METRICS

A Series of In-Service
Booklets Designed for
Adult Educators

Booklets in This Series

Booklet One: Before You Begin Teaching Metrics
Booklet Two: Metric Readiness
Booklet Three: Measuring Length and Area
Booklet Four: Measuring Volume
Booklet Five: Measuring Weight
Booklet Six: Determining Temperature
Booklet Seven: Conversion Between Metric Units

This guide was developed pursuant to project No. 018A76SD with the Division of Federal Assistance, Ohio Dept. of Education. The activity which is the subject of this report was supported in whole and in part by the U.S. Office of Education, Department of Health, Education, and Welfare. However, opinions expressed herein do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

Diane Girard, Dayton Public Schools

Robert Wendel, Miami University

Co-Directors

Measuring Volume

Unit Objectives:

The student should be able to:

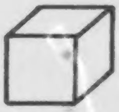
1. Write the seven units of volume measurement and their correct symbols in order.
2. Identify the name of a unit when presented.
3. Estimate the volume of an item.
4. Measure the volume of an item accurately.
5. Identify the units used for gasoline, milk, cough medicine, baby food, recipes, etc.

In addition to measuring length and area, we also need to measure the volume (or capacity) of jars, cans, bottles, and boxes. We must know how much gasoline to buy, or how much heating oil we have used. In the customary system we use fluid ounces, teaspoons, tablespoons, cup, pints, quarts, and gallons for these situations. In the metric system we will only use liters and milliliters!

Actually, the liter is defined from linear measure. So let us examine how linear measure is adapted to measure volume. Look, for example, at the centimeter. From it we have already developed the square centimeter (cm^2) in the previous section. Consider a box whose every edge is a centimeter and each face is a square centimeter. This box would be called a cubic centimeter or cm^3, as shown in the diagram below.

1 cm

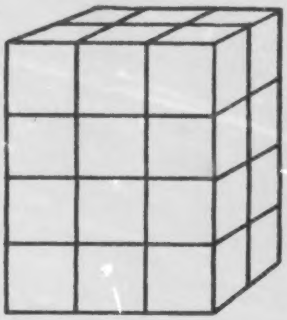
$1\ cm^2$



$1\ cm^3$

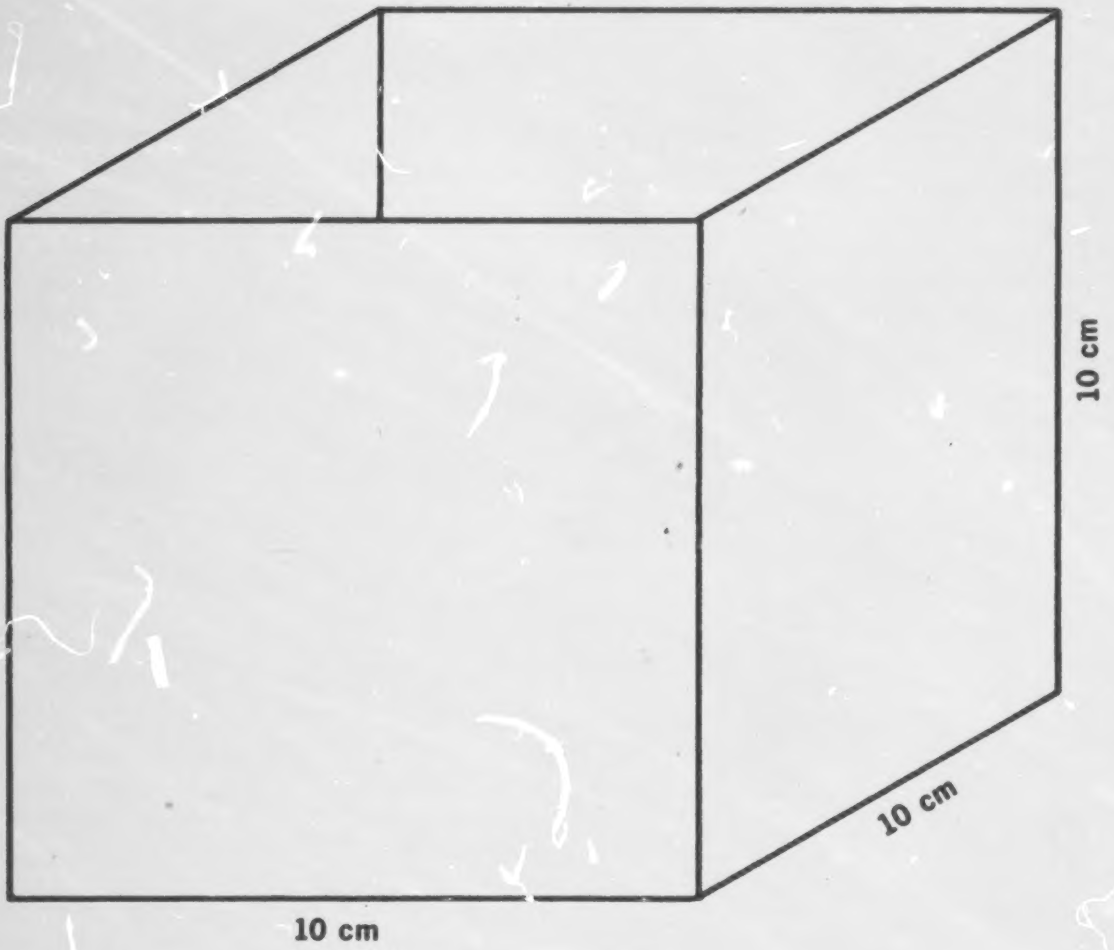
The box could be used as a unit to measure how much a jar would hold. Actually, you may already have heard of a cubic centimeter through the older name "cc". Vaccinations frequently are measured as 2 or 3 cc's. This, of course, is our cubic centimeter or cm^3. Probably, both names "cc" and "cm^3" will be used for a little while. We should try to use cm^3 for accuracy, however.

Volume should be thought of as answering this question. "How many cubes are in this stack?" Look at this drawing:

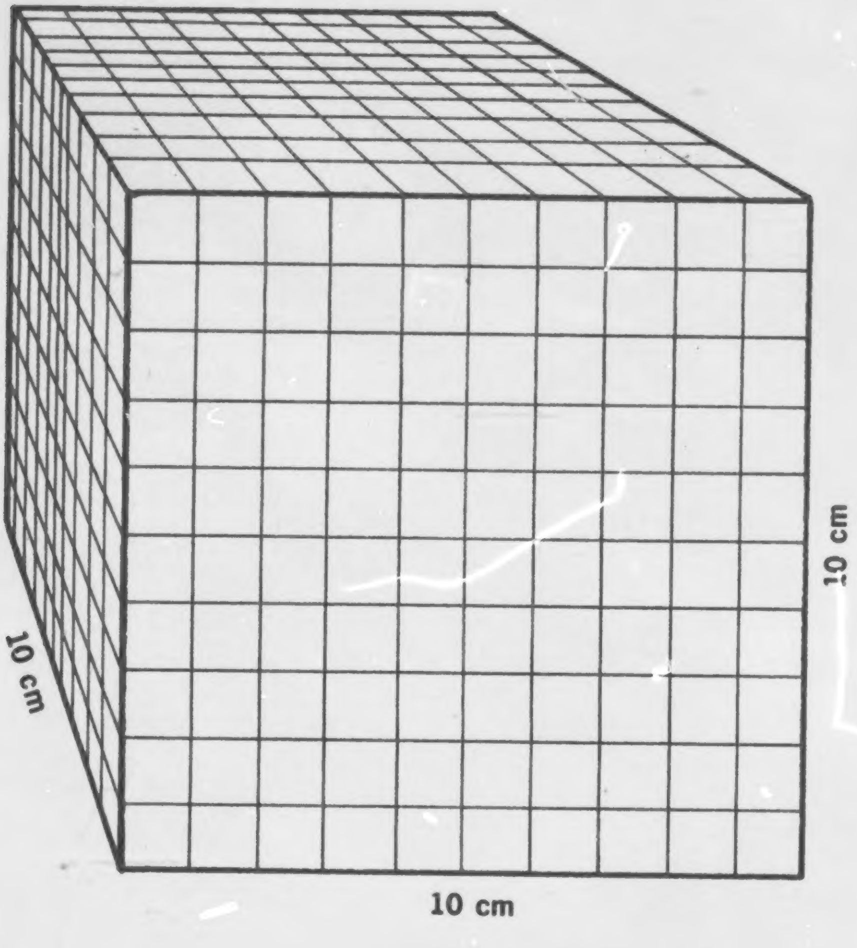


If each block is one cm^3 we can talk about the volume of this stack in cubic centimeters. There are $6cm^3$ in the bottom layer of this stack. Then there are 4 layers of blocks. So that gives us 24 cm^3 as the volume (or the measure of space) in the whole stack. The formula for volume of a straight up stack is V = BH where "B" (base = length X width) stands for the number of units needed to cover the base or bottom and "H" refers to the number of layers or height of the stack.

The cm^3 is too small, though, to be used for measuring such things as milk in the store or gasoline at the service station. For that a bigger box is needed. Think of a box which is ten (10) centimeters on each edge. Such a box is pictured on the next page. This size container holds one LITER. The LITER is the fundamental unit of liquid measure in the metric system.


10 cm
10 cm
10 cm

A box which is 10 cm by 10 cm on the bottom and also 10 cm high holds one LITER.


10 cm
10 cm
10 cm

This liter box 10 × 10 × 10 will hold
1000 cubic centimeters.

In the liter box there would be a bottom layer which would hold 100 cm^3 (10 X 10). The box is 10cm tall (or high or deep). So there would be 10 layers like the bottom one. If we multiply 10 layers X 100cm^3 in each layer, we find that the liter box holds 1000 cm^3 or one thousand cubic centimeters. So, one cubic centimeter is 1/1000 of a liter. Since "milli" means 1/1000 in the metric system, each small cubic centimeter is also called a milliliter. A full liter holds 1000 milliliters; a half a liter is 500 milliliters (ml); a fourth of a liter is 250ml, and so forth. We will buy gasoline by the liter and put milk into a recipe in milliliters. The full liquid measure (or capacity) picture is:

Symbol	Prefix	Numerical Meaning
kl	kiloliter	1000 liters
hl	hectoliter	100 liters
dkl	dekaliter	10 liters
l	liter	1 liter
dl	deciliter	.1 liters
cl	centiliter	.01 liters
ml	milliliter	.001 liters

But we will generally only use liters and milliliters in our daily lives. Kiloliters will probably be used to measure large tank trucks, city water towers, etc.

Teaching Strategies

Remember, the key to teaching metrics is to use equipment and let the students measure with that equipment! You should have the following materials:

1. A liter box.
2. Several cubic centimeters.
3. A liter pitcher which is calibrated to 50ml or 100ml. (You could also have smaller pitchers and perhaps even some 5ml, 10ml, and 25ml spoon sets.)
4. Many common containers from baby food jars or flavoring bottles to pickle and mayonnaise jars or pop bottles or even large buckets or bottles. The more variety in the size and shape of these containers the better.
5. Water.
6. Food coloring added to the water makes measuring easier and adds a little jazz to your activities.

Steps:

1. Explain the liter and milliliter using the liter box and cubic centimeters.
2. Demonstrate that the liter box full of water will fill the liter pitcher and that half the box comes up to the 500ml mark on the pitcher.
3. Fill the pitcher up to various levels (300ml, for example) and ask your students to tell you how much it looks like when you hold it up so they can see it. They should guess within a hundred milliliters.
4. Now place the various containers, pitchers, and water out where students can use them. Groups of approximately three students usually work out well for these measuring activities. Encourage students to GUESS the capacity of each vessel before they

measure with the pitcher. A five step process is suggested:

A) Guess (alone as an individual).
B) Record the guess on a sheet of paper.
C) Measure as a group.
D) Record the measurement in liters or milliliters.
E) Compare the guess with the measurement.
ALWAYS WRITE THE UNIT OF MEASURE AFTER THE NUMBER!
Right : This jar holds 175ml.
Wrong : This jar holds 175.

5. Encourage your students to observe that a liter is approximately a quart, a teaspoon about 5ml, a cup about 250ml, a gallon about 4 liters, and so forth.
6. Other basic activities may then be used to follow up the basic measuring experiences.

A) Make statements and ask "Would this be reasonable?" *Examples:* "I drank 20 liters of milk." (NOT REASONABLE): "I bought 40 liters of gas." (YES, REASONABLE).

B) Give an approximate amount to each situation:
   1. A fill-up at the gas station.
   2. A glass of water.
   3. Add a ________ of oil to my car.
   4. This punchbowl holds _______.

C) Show a cubic meter in some way. Maybe get a washing machine carton or some such box which is generally close to a meter on each side. Students will generally be surprised at how much a cubic meter of concrete, water, or soil, really is.

D) Use a worksheet to provide practice with equivalents like:

500ml = ½ liter
250ml = ¼ liter
1000ml = 1 liters
3000ml = 3 liters

Teaching Evaluation

If you have done your teaching job well, your students will be able to:

1. Use a calibrated (ml and l) pitcher to measure how much a container holds.
2. Reasonably estimate the capacity in milliliters of containers from medicine bottles up to large pop bottles.
3. Give a good estimate of the capacity in liters of larger milk containers, cooking pots, and small buckets.
4. Use liters and milliliters in casual conversation.
5. Change from liter to milliliters and vice versa.

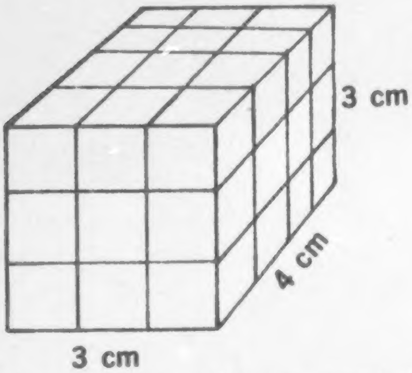
NEW METRIC CONTAINER SIZES

New Metric Sizes	Closest Present American System Container	Average Bottles per Case
1.75 Liter	½ Gallon	6
1 Liter	1 Quart	12
750 Milliliters	5th	12
500 Milliliters	Pint	24
Special Orders ONLY		
250 Milliliters	½ Pint	60
50 Milliliters	Miniature	120

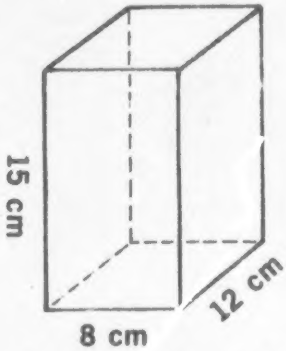
Sample Written Exercises

1. One common unit of volume is the cubic centimeter (cm^3). How many cubic centimeters are there in each of the following?

a.



b.



2. Cubic meters will be used to measure which of the following?

   a. Space in a room.
   b. Baking powder in biscuits.
   c. Gasoline for your car.
   d. Concrete for a driveway.

3. a. One liter = ________milliliters.
   b. 6 liters = ________milliliters.
   c. ________liters = 1 kiloliter.
   d. ½ liter = ________milliliters.

4. From the list at the right, select a reasonable measure.

_____milk in a cake recipe

_____fill-up at the service station

_____contents of a carton of milk

_____a spoonful

a. 5ml

b. 60 liters

c. 400ml

d. 2 liters

e. 700 liters

5. a. One cubic centimeter = _______ml.

b. ml means ______________________.

c. kl means ______________________.

d. cl means ______________________.

6. What unit would be used to measure: (choose from ml, l, kl)

a. medicine in a dose _____

b. coffee in a cup _____

c. oil carried by a river barge _____

d. capacity of a bathtub _____

Do Your Answers Agree With These?

1. A) 36cm^3
   B) 1440cm^3

2. A, D

3. A) 1000 milliliters
   B) 6000 milliliters
   C) 1000 liters
   D) 500 milliliters

4. C
   B
   D
   A

5. A) 1 milliliter
   B) milliliter
   C) kiloliter
   D) centiliter

6. A) ml
   B) ml
   C) kl
   D) l

Resources: Volume Measurement

Averett, Dorothy M., Bernice O. Crump, and Gerda I. Rosenbaum. *Think Metric*, New York: William H. Sadlier, Inc., 1976. pp. 28-33.

Bitter, Gary G., Jerald L. Mikesell, and Kathryn Maurdeff. *Activities Handbook for Teaching the Metric System*, Boston: Allyn and Bacon, Inc., 1976. pp. 195-237.

Buckeye, Donald. I'm O.K. You're O.K., *Let's Go Metric*, Troy, Michigan: Midwest Publications, 1973. pp. 35-41.

Buckeye, Donald. *Introducing the Metric System With Activities*, Troy, Michigan: Midwest Publications, 1972. pp. 15-18.

Clack, Alice A., and Carol H. Leitch. *Amusements in Developing Metric Skills*, Troy, Michigan: Midwest Publications, 1973. pp. 30-35.

Fugate, Sarah P. and Barbara H. LeGette. *Listening Your Way to Understanding the Metric System*, New York: Classroom World Productions, 1074. Lesson 5.

Gilbert, Thomas F., and Marilyn B. Gilbert. *Thinking Metric*, New York: John Wiley and Sons, Inc., 1973. pp. 43-51.

Hartsuch, Paul J. *Think Metric Now!*, Chicago: Follett Publishing Co., 1974. pp. 35-42.

Hoffman, Sylvia A. *Metrication Masters*, New York: Holt, Rinehart, and Winston, 1974. pp. 44-46.

Introducing the Metric System, Santa Monica, California: BFA Educational Media, 1972. Group 3. (Multimedia).

Let's Measure Metric, Columbus, Ohio: Ohio Dept. of Education, 1975. pp. 19-26.

Massey, Opal. *Metrics for Home Use*, Stockton, California: Willow House Publishers, 1975. pp. 24-26.

The Metric System, Menlo Park, California: Addison-Wesley Publishing Co., 1974. pp. 42-53.

Metric System Skills, Freeport, New York: Educational Activities Inc., 1973. AR723. (recording).

Resources: Volume Measurement (cont')

The Metric System - What It Is and How to Use It, New York: Preston Publishing Co., Inc., 1975. pp. 26-30.

Miller, Mary R. and Toni C. Richardson. Making Metric Manuevers, Hayward, California: Activity Resource Co., 1974. pp. 54-70.

Odom, Jeffery, Metric Measurement Kit, Columbus, Ohio: Xerox Education Publications, 1975. Volume 4. (multimedia).

Ploutz, Paul F. The Metric System: A Programmed Approach, Columbus, Ohio: Charles E. Merrill Publishing Co., 1972. pp. 71-81.

Rabenau, Diane F. The Metric System, Salem, Ohio: Macmillan Media Associates, 1974. pp. 16-20.

Rahn, Joan Elma. The Metric System, New York: Atheneum, 1976. pp. 39-48.

Sorenson, Juanita S. Measuring In Metrics, Eau Claire, Wisconsin: Pencraft, 1975. pp. 37-46.

Think Metric - Understanding and Using the Metric System, Chicago: Denoyer-Geppert Audio-Visuald, 1973. Group 7, 8. (slides).

Wallace, Jesse D. The Metric Pal, Chico, California: Jesse D. Wallace, 1976. pp. 17-20.

Witte, Carol, and Betty Long. Fun With Metric Measurements, Manhatten Beach, California: Teachers, 1973. pp. 55-60.

BOOKLET

5

MEASURING WEIGHT

A Teacher's Guide to Metrics

Johnny Hill, author   Robert Wendel, editor

A TEACHER'S GUIDE TO METRICS

A Series of In-Service
Booklets Designed for
Adult Educators

Booklets in This Series

Booklet One:	Before You Begin Teaching Metrics
Booklet Two:	Metric Readiness
Booklet Three:	Measuring Length and Area
Booklet Four:	Measuring Volume
Booklet Five:	Measuring Weight
Booklet Six:	Determining Temperature
Booklet Seven:	Conversion Between Metric Units

This guide was developed pursuant to project No. 018A76SD with the Division of Federal Assistance, Ohio Dept. of Education. The activity which is the subject of this report was supported in whole and in part by the U.S. Office of Education, Department of Health, Education, and Welfare. However, opinions expressed herein do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

Diane Girard, Dayton Public Schools

Robert Wendel, Miami University

Co-Directors

Measuring Weight

Unit Objectives:

The student should be able to:

1. Write the seven units of mass measurement and their correct symbols in order.
2. Identify the name of the unit when presented.
3. Estimate the mass of an object.
4. Measure the mass of an object accurately.
5. Know their own mass.

How much hamburger should I buy? How much do I weigh? What are the load limits on that old bridge over Dry Creek? These are questions not answered using length units like meters or centimeters, or units of capacity like liters or milliliters. These questions and many more like them are about the amount of matter or substance. In our country we use ounces, pounds and tons for most of these situations. In doing so we say we are talking about the "weight" of something.

In the metric system, the basic unit of "mass" is the kilogram. Mass refers to the amount of matter. Mass is not exactly the same thing as weight. Weight is determined by scales, and scales actually measure the force or pull of gravity. Thus, you may stand on a scale in Toledo and note you weigh 160 pounds. However, if we carry you and the scale to the moon where the force of gravity is less, you might only weigh 30 pounds.

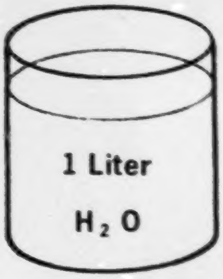
Now suppose we measure you differently. We will use a balance which has a big pan on both sides (like a see-saw). We put you on one side and 50 bricks on the other side and our see-saw balances! We say your mass is 50 bricks. If we transport you, the balance, and the bricks to the moon, it would still balance! Your "mass" remained the same, whereas your weight changed. Gravity affects weight; it does not affect mass.

Don't be confused over the difference between mass and weight. However, as a teacher you should know that the international metric unit is a mass unit. In most countries people will probably not distinguish between weight and mass in their everyday affairs. So we suggest you use the mass units described here to weigh things.

The standard unit in the world for mass is a platinum cylinder kept in Paris at the International Bureau of Weights and Measures. Its mass is one kilogram. Historically however, the kilogram came from the linear system of meters and centimeters, and this development probably will give your students their best idea of how to weigh things in the metric system.

Just as the liter came out of the linear metric units, the two principal metric weight units of kilogram and gram developed from the capacity units. Recall the liter box. It is a box 10 centimeters on each side. If you fill the box with lead or gold, it would be fairly heavy. If you fill it with cotton it would be much lighter. So a liter of various substances can weigh differently.

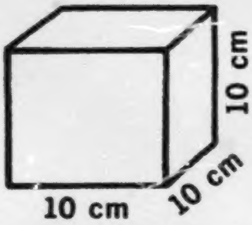
Consider a liter of our most common liquid - WATER. A liter of water weighs a kilogram. Kilogram is the most used weight in the metric system.



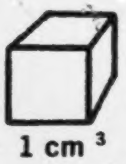
1 liter of water weighs 1 kilogram.

Back to weight. If a liter of water weighs a kilogram and "kilo" means thousand, then kilogram means a thousand grams. Thus, a liter of water weighs a thousand grams. Or, one-thousandth (1/1000) of a liter weighs a gram. Ah-hah! But 1/1000 of a liter is a milliliter. So one milliliter of water weighs one gram! Let's look at it.

1 liter weighs 1 kilogram
or
1 liter weighs 1000 grams
or
1000 milliliters weighs 1000 grams
so,
1 milliliter weighs 1 gram
and
1 cubic centimeter weighs 1 gram.



1 liter of water weighs
1 kilogram (1kg).



1 cubic centimeter =
1 milliliter of water
weighs 1 gram (1g).

Note: These two drawings are not in the same scale.
Recall it takes 1000cm^3 to make a liter.

The total weight picture looks like this:

Symbol	Name	Numerical Meaning
kg	kilogram	1000 grams
hg	hectogram	100 grams
dkg	dekagram	10 grams
g	gram	1 gram
dg	decigram	.1 grams
cg	centigram	.01 grams
mg	milligram	.001 grams

You probably have heard these units mentioned many times. Advertisements about vitamins commonly use milligrams. Items such as meat, cheese, sugar, fresh fruit, and vegetables will commonly be sold by the "kilo". The "kilo", of course, refers to kilogram. In discussion of grain shipments, politicians and government officials cite the number of metric tonnes of wheat we have sold to Russia or other countries. A metric tonne is 1000 kilograms.

Teaching Strategies

As before, the important idea on teaching metrics is let your students measure! In this case, let them weigh things. You should have the following *materials*.

1. A metric bathroom scale.
2. A large capacity balance with buckets on either side.
3. A collection of "weights" in the sizes of 100g, 50g, 20g, 10g, and 5g. (You should have several of each.)
4. Various objects to weigh. Bags of sugar, cans of beans, books, blackboark erasers, or bricks. The more you have the better.
5. A kitchen type scale whose capacity is approximately 5kg.
6. A smaller balance of the type used in a laboratory would also be helpful. If you have one of these, you will need smaller weights like 1 and 2 grams, unless it has a sliding weight already on it. A hanging scale would also be useful.

A suggested strategy might be as follows:

1. Explain how the kilogram and gram were developed using the liter box, water, and perhaps a plastic cm^3 which has been designed to weigh 1 gram.

2. Let students hold the liter box of water and let them hold a kilogram weight. Use the bucket balance to show they are the same weight.
3. Fill the liter box half full. Ask how much it weighs. Show that it weighs approximately 500 grams.
4. Place the weights, balances, and objects to be weighed around the room. Have a small group of 3 or 4 students hold the weights, then try to approximate the weight of an object. Now, have them weigh the objects by putting the object in one side of the balance and placing weights on the other side until they are balanced. The same four step process is encouraged:
   - A) Guess (alone as an individual).
   - B) Record the guess on a sheet of paper.
   - C) Measure the object as a group.
   - D) Record the measurement in grams or kilograms.
   - E) Compare the guess with the measurement.

   ALWAYS WRITE THE UNIT OF MEASURE AFTER THE NUMBER!

   Right: This can weighs 540g.
   Wrong: This can weighs 540.
5. Now use the bathroom scales. Ask the class to estimate the weight of some middle-sized person. They will probably be frustrated. So, weigh that person. Announce the weight. Then ask the class to guess a smaller person's weight. They will now do a little bit better at guessing. Weigh the second person. With these experiences, the class will probably improve their ability to guess -- and all WITHOUT CONVERSION.

When this activity is first tried many students will be sure they cannot guess without converting. But with more and more examples, students will see that they can.

6. Get a pound of something. Have students estimate and weigh it metrically so that they get some idea that a pound is slightly less than 500 grams. They can conclude that a kilogram is a bit more than 2 pounds. AVOID doing exercises or problems that require complicated calculated conversion back and forth.
7. Use a kitchen type scale. Let small groups measure objects using the scale.
8. Other activities:
    - A) Use "Would this be reasonable?" statements such as "I weigh 90 grams," "The recipe calls for 20kg of flour," or "This bridge will only hold 100kg."
    - B) Give an approximate weight to each situation: A baby at birth. A bottle of pop. An order of hamburger at the grocery. The weight of an automobile. One banana weighs ______.
    - C) Bring in objects that have metric weights on them. Compare (NOT CONVERT) approximate metric weights and customary weights.
    - D) Look at some of the ridiculous weights on products we buy, for example, a box of cereal that weighs 11 3/4 ounces. Discuss and list some metric weights that would be more convenient for possible new standard size packages.
    - E) Have students cut out pictures of objects from magazines. Either put an approximate weight on each, or have multiple choices of weights from which other students can choose the most reasonable one.
    - F) Actually prepare some cookies or some other easy treat IN CLASS. Sample recipes can be found in resources at the end of this unit.

Teaching Evaluation

If you have done your teaching job well, your students will be able to:

1. Reasonably estimate the weight of common everyday objects from a spoon of water weighing 5 grams up to people's weights.
2. Use grams and kilograms in casual conversation. (In fact, they should jokingly try to talk grams and kilograms. Example: If I eat that piece of cake, I'll gain another kilogram.)
3. Recognize and write the words kilogram, gram, and milligram and their symbols (kg, g, mg).
4. Give their own weight in kilograms.
5. Change from grams to kilograms and vice versa.

   Example: 3000g = ______kg (answer 3kg)
   400g = ______kg (answer .4kg)
   2500g = ______kg (answer 2.5kg)
   8kg = ______g (answer 8000g)

Sample Written Exercises

1. Rearrange these units in order from smallest to largest:

   dg, milligram, dkg, cg, gram, kg, hectogram

2. a. What does one ml of water weigh? ____________

   b. One liter of water weighs ____________grams or

   __________kg.

3. a. 6000g = _______kg

   b. 4000mg = _______g

   c. 2 kg = _______g

   d. ½kg = _______g

4. From the list at the right select a reasonable measure:

   _____ weight of a new-born baby — a. 115kg

   _____ weight of an automobile — b. 1500kg

   _____ weight of a Bengal linebacker — c. 30kg

   _____ weight of a baking potato — d. 300g

   e. 3½kg

5. Recall that a metric tonne is 1000kg.

   7 tonnes = ________kg

6. What unit would be used to measure: (choose from mg, g, kg, and tonne).

a. A person's weight? ________

b. A small can of corn? ________

c. Ohio's yearly corn harvest? _______

d. Weightlifting contest? ________

e. Active ingredients in one asprin? ________

Do Your Answers Agree With These?

1. Smallest to largest arrangement is:
   milligram, cg, dg, gram, dkg, hectogram, kg

2. A) 1 gram
   B) 1000 grams or 1 kg

3. A) 6kg
   B) 4g
   C) 2000g
   D) 500g

4. E
   B
   A
   D

5. 7000kg

6. A) kg
   B) g
   C) tonne
   D) kg
   E) mg

Resources: Mass Measurement

Averett, Dorothy M., Bernice O. Crump, and Gerda I. Rosenbaum. Think Metric, New York: William H. Sadlier Inc., 1976. pp. 34-40.

Bitter, Gary G., Jerald L. Mikesell, and Kathryn Maurdeff. Activities Handbook for Teaching the Metric System, Boston: Allyn and Bacon, Inc., 1976. pp. 143-194.

Buckeye, Donald. I'm O.K. You're O.K., Let's Go Metric, Troy, Michigan: Midwest Publications, 1973. pp. 51-52.

Buckeye, Donald. Introducing the Metric System With Activities, Troy, Michigan: Midwest Publications, 1972. pp. 21-22.

Clack, Alice A. and Carol H. Leitch. Amusements in Developing Metric Skills, Troy, Michigan: Midwest Publications, 1973. pp. 22-29.

Fugate, Sarah P. and Barbara H. LeGette. Listening Your Way to Understanding the Metric System, New York: Classroom World Productions, 1974. Lesson 4.

Gilbert, Thomas F., and Marilyn B. Gilbert. Thinking Metric, New York: John Wiley and Sons, Inc., 1973. pp. 52-62.

Hartsuch, Paul J. Think Metric Now! Chicago: Follett Publishing Co., 1974. pp. 3-12.

Hoffman, Sylvia A. Metrication Masters, New York: Holt, Rinehart, and Winston, Inc., 1974. pp. 25, 38, 46.

Let's Measure Metric, Columbus, Ohio: Ohio Dept. of Education, 1975. pp. 27-30.

Massey, Opal. Metrics for Home Use, Stockton, California: Willow House Publishers, 1975. pp. 27-28.

The Metric System, Menlo Park, California: Addison-Wesley Publishing Co., 1974. pp. 54-74.

Metric System Skills, Freeport, New York: Educational Activities Inc., 1973. AR7222. (Recording).

The Metric System - What It Is and How to Use It, New York: Preston Publication Co. Inc., 1975. pp. 32-34.

Resources: Mass Measurement (cont')

Miller, Mary R. and Toni C. Richardson. Making Metric Manuevers, Harward, California: Activity Resource Co., 1974. pp. 71-81.

Odom, Jeffrey, Metric Measurement Kit, Columbus, Ohio: Xerox Education Publications, 1975. Volume 3. (multimedia).

Ploutz, Paul F. The Metric System: A Programmed Approach, Columbus, Ohio: Charles E. Merrill Publishing Co., 1972. pp. 71-81.

Rabenau, Diane F. The Metric System, Salem, Ohio: MacMillan Media Associates, 1974. pp. 21-23.

Rahn, Joan Elma. The Metric System, New York: Atheneum, 1976. pp. 49-53.

Sorenson, Juanita S. Measuring In Metrics, Eau Claire, Wisconsin: Pencraft, 1975. pp. 47-54.

Think Metric - Understanding and Using the Metric System, Chicago: Denoyer-Geppert Audio-Visuals, 1973, Group 1. (slides).

Wallace, Jesse D. The Metric Pal, Chico, California: Jesse D. Wallace, 1976. pp. 14-16.

Witte, Carol and Betty Long. Fun With Metric Measurement, Manhattan Beach, California: Teachers, 1973. pp. 61-65.

BOOKLET

6

DETERMINING TEMPERATURE

A Teacher's Guide to Metrics

Johnny Hill, author

Robert Wendel, editor

A TEACHER'S GUIDE TO METRICS

A Series of In-Service
Booklets Designed for
Adult Educators

Booklets in This Series

Booklet One: Before You Begin Teaching Metrics

Booklet Two: Metric Readiness

Booklet Three: Measuring Length and Area

Booklet Four: Measuring Volume

Booklet Five: Measuring Weight

Booklet Six: Determining Temperature

Booklet Seven: Conversion Between Metric Units

This guide was developed pursuant to project No. 018A76SD with the Division of Federal Assistance, Ohio Dept. of Education. The activity which is the subject of this report was supported in whole and in part by the U.S. Office of Education, Department of Health, Education, and Welfare. However, opinions expressed herein do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

Diane Girard, Dayton Public Schools

Robert Wendel, Miami University

Co-Directors

Determining Temperature

Unit Objectives:

The student should be able to:

1. Identify the freezing and boiling points of water on the Celsius scale.
2. Estimate temperature.
3. Measure temperature accurately.
4. Identify normal body temperature, room temperature, and ranges of temperatures for warm, cool and cold days, outside.

The temperature scale in metrics is called the Celsius scale (C). In the Celsius scale water boils at 100°C and freezes at 0°C. This scale is sometimes called the Centigrade scale, but the internationally accepted term is Celsius. We should note initially that in the Celsius scale there are 100° between freezing and boiling whereas there are 180° between the freezing (32°F) and boiling temperature (212°f) of the Fahrenheit scale.

This means that a degree change in Celsius is more of a change than a degree change in Fahrenheit. For example, if a person has a fever of 3°C, that is more fever than 3° Fahrenheit.

On the Celsius scale, the following are common marks you can use to judge approximate temperatures:

Oven for baking biscuits	230°C
Oven for roasting turkey	160°C
Very slow oven	120° to 140°C
Boiling water	100°C
Hot water	50°C
Normal body temperature	37°C
Sunbathing day	30°C

Room temperature	21°C
Cool fall evening	10°C
Water freezes	0°C
Cold winter day (Ohio)	-15°C

Teaching Strategies

You should have the following *materials:*

1. A room thermometer.
2. A laboratory type thermometer.
3. An outside thermometer.

You (or your students) should probably make a large wall chart showing a thermometer using the Celsius scale. The scale on the next page is an example. Beside the appropriate temperature list some of the common temperatures such as body temperature, freezing etc.

Your teaching strategy is still activity-type learning. Some activities might be:

1. Let students read a thermometer with indoor and outdoor temperatures.
2. Put ice cubes in a glass, place the Celsius thermometer into the melting ice cubes and read the temperature. Adding some rock salt to the ice cubes makes an interesting follow up experiment demonstrating melting speed and temperature.
3. Place a thermometer in hot water. Read the thermometer and have students touch the water to see what water of 40°C feels like. Measure the temperature of lukewarm, warm, and cold water. Have students check water in the building.

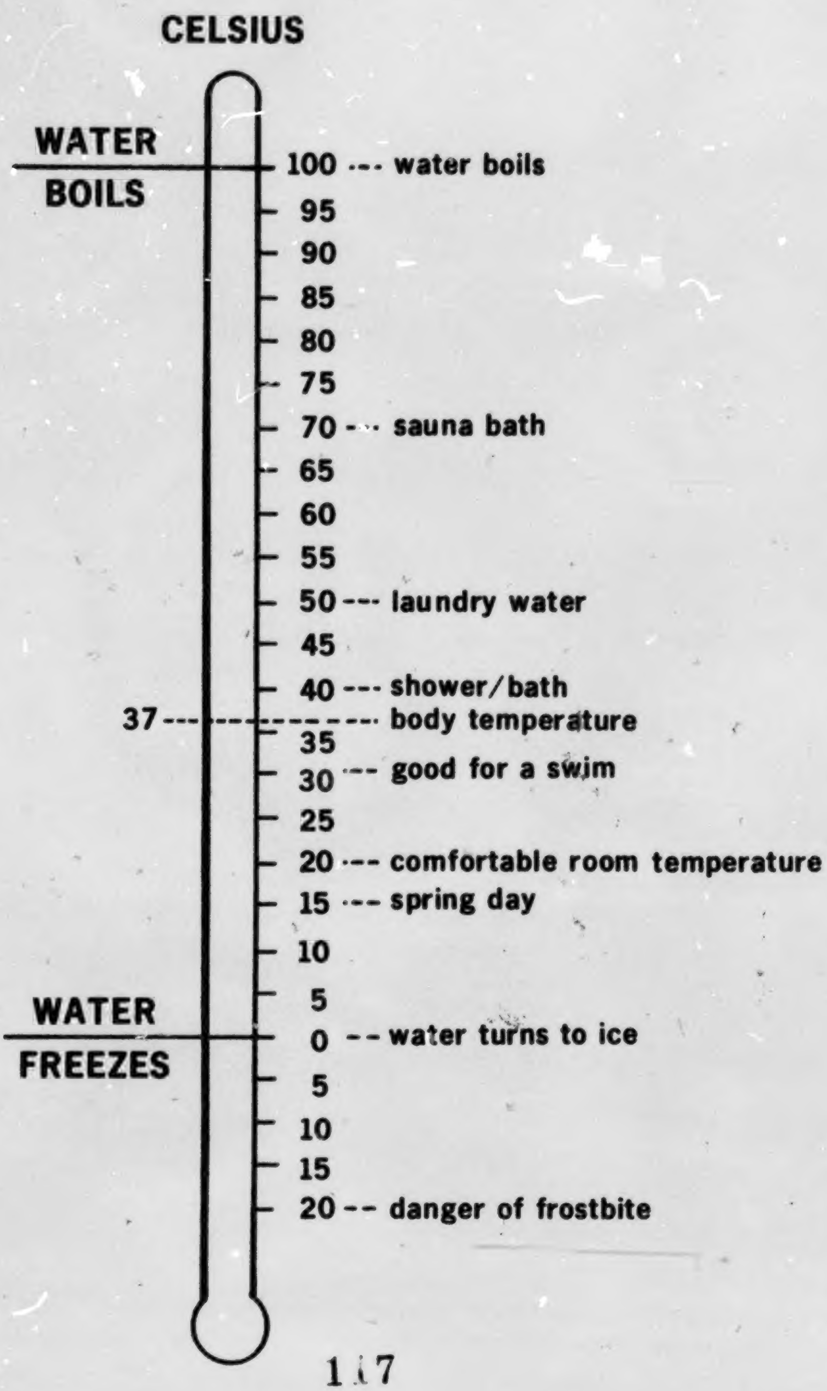
NEVER PLACE YOUR HAND IN WATER HOTTER THAN 60°C!

4. Keep a class record of temperatures reported in Celsius by the local TV radio station.
5. Check the temperature in a refrigerator and freezer.
6. Check the temperature of hot coffee. "How hot do you like your coffee?"

Teaching Evaluation

If you have done your teaching job well, your students will be able to:

1. Read a Celsius thermometer.
2. Supply an approximate Celsius temperature when given a common description (summer day, body temperature, etc.) and vice versa.


CELSIUS
WATER
BOILS
100 --- water boils
95
90
85
80
75
70 --- sauna bath
65
60
55
50 --- laundry water
45
40 --- shower/bath
37 -------------- body temperature
35
30 --- good for a swim
25
20 --- comfortable room temperature
15 --- spring day
10
5
WATER
FREEZES
0 -- water turns to ice
5
10
15
20 -- danger of frostbite

Sample Written Exercises

1. The freezing point of water is:
    - a. 30°C
    - b. 15°C
    - c. 0°C

2. The boiling point of water is:
    - a. 100°C
    - b. 212°C
    - c. 10°C

3. A person who is ill with fever might have a temperature of:
    - a. 38.3°C
    - b. 10.3°C
    - c. 84.2°C

4. A typical temperature for a July day in Dayton is:
    - a. 31°C
    - b. 90°C
    - c. -5°C

5. A typical temperature for a December day in Cincinnati is:
    - a. 30°C
    - b. 90°C
    - c. -5°C

6. A cake is baked at a temperature of:
    - a. 190°C
    - b. 85°C
    - c. 16°C

7. A freezer has a temperature of:

a. -18°C
b. 8°C
c. -1°C

8. An air conditioner is set to maintain:

a. 22°C
b. 52°C
c. 70°C

9. Water used to wash dishes by hand should be about:

a. 20°C
b. 50°C
c. 200°C

10. Iced tea drinkers like their tea at:

a. -2°C
b. 7°C
c. 35°C

Do Your Answers Agree With These?

1. C

2. A

3. A

4. A

5. C

6. A

7. A

8. A

9. B

10. B

Resources: Temperature

Averett, Dorothy M., Bernice O. Crump, and Gerda I. Rosenbaum. *Think Metric*, New York: William H. Sadlier, Inc., 1976. pp. 42-45.

Bitter, Gary G., Jerald L. Mikesell, and Kathryn Maurdeff. *Activities Handbook for Teaching the Metric System*, Boston: Allyn and Bacon, Inc., 1976. pp. 238-260.

Buckeye, Donald. *I'm O.K., You're O.K., Let's Go Metric*, Troy, Michigan: Midwest Publications, 1973. pp. 42-46.

Cunningham, James B. *Teaching Metrics Simplified*, Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1976. pp. 135-156.

Hartsuch, Paul J. *Think Metric Now!* Chicago: Follett Publishing Co., 1974. pp.50-55.

Hoffman, Sylvia A. *Metrication Masters*, New York: Holt, Rinehart, and Winston, Inc., 1974. pp. 47-78.

Let's Measure Metric, Columbus, Ohio: Ohio Dept. of Eudcation, 1975. pp. 31.

The Metric System, Menlo Park, California: Addison-Wesley Publishing Co., 1974. pp. 76-85.

Miller, Mary R. and Toni C. Richardson. *Making Metric Manuevers*, Hayward, California: Activity Resources Co., 1974. pp. 82-89.

Rabenau, Diane F. *The Metric System*, Salem, Ohio: Macmillan Media Associates, 1974. pp. 24-26.

Rahn, Joan Elma. *The Metric System*, New York: Atheneum, 1976. pp. 54-60.

Sorenson, Juanita S. *Measuring In Metrics*, Eau Claire, Wisconsin: Pencraft, 1975. pp. 55-68.

Think Metric - Understanding and Using the Metric System, Chicago: Denoyer-Geppert Audio-Visuals, 1973. Group 10. (slides).

Witte, Carol, and Betty Long. *Fun With Metric Measurement*, Manhatten Beach, California: Teachers, 1973.pp. 77-79.

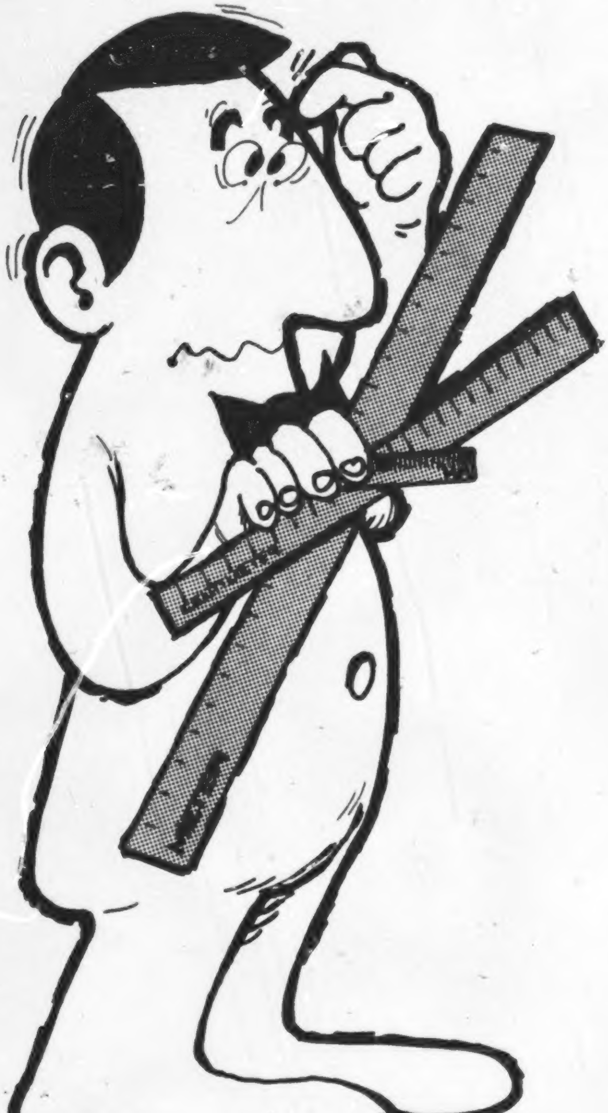
BOOKLET

7

CONVERSION BETWEEN METRIC UNITS

A Teacher's Guide to Metrics

Diane Girard, author
Johnny Hill, author
Robert Wendel, editor



A TEACHER'S GUIDE TO METRICS

A Series of In-Service
Booklets Designed for
Adult Educators

Booklets in This Series

Booklet One:	Before You Begin Teaching Metrics
Booklet Two:	Metric Readiness
Booklet Three:	Measuring Length and Area
Booklet Four:	Measuring Volume
Booklet Five:	Measuring Weight
Booklet Six:	Determining Temperature
Booklet Seven:	Conversion Between Metric Units

This guide was developed pursuant to project No. 018A76SD with the Division of Federal Assistance, Ohio Dept. of Education. The activity which is the subject of this report was supported in whole and in part by the U.S. Office of Education, Department of Health, Education, and Welfare. However, opinions expressed herein do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

Diane Girard, Dayton Public Schools

Robert Wendel, Miami University

Co-Directors

Conversion Between Metric Units

Unit Objectives:

The student should be able to:

1. Change a measurement from one metric unit to another metric unit.

If a student is to master metrication and feel comfortable in its usage, he must be competent in converting measurements. For instance, a homemaker needs 50 centimeters of trim to finish a pillow. If she has four pillows, she will need 200 centimeters all together. Since trim will be sold in meters, she will need to know that 200 centimeters is the same as 2 meters.

Probably the best way to show this metric-to-metric conversion is to use something you already know is metric - *money*! Take an example of 438 cents. This amount can be written as 4.38 dollars.

438 cents = 4.38 dollars

or

438¢ = $4.38

These are the same amounts of money, but they may look differently when written down. The 4, 3, and 8 are the same and are in the same order, but the decimal point is in different places in the two amounts. Recall that 438. is the same as 438 without the decimal point. You have the same in the metric system.

438 centimeters = 4.38 meters

or

438cm = 4.38 m

Why does this happen? There are 100 cents in a dollar and 100 centimeters in a meter. If you change from dollars to cents, you multiply by 100.

For example: 5 dollars X 100 cents = 500 cents
4.60 dollars X 100 cents = 460 cents
5.46 dollars X 100 cents = 546 cents

In reverse order, if you change from cents to dollars, you divide by 100.

For example: 700 cents ÷ 100 = 7 dollars
890 cents ÷ 100 = 8.90 dollars
742 cents ÷ 100 = 7.42 dollars

You can compare money and metrics as well. A dime is .1 (one tenth) of a dollar; a decimeter is .1 of a meter. Look at this chart and think of 16 dimes.

Dollars	Dimes	Cents
1.6	16.	160

This works well because 10 is the factor between each pair of columns. Ten cents = 1 dime; ten dimes = 1 dollar. Or in reverse order, .1 dollar = 1 dime; .1 dime = 1 cent.

Converting among metric units is similar. The table below shows relationships between the meter and other units.

1 meter = 10 decimeters
1 meter = 100 centimeters
1 meter = 1000 millimeters

or

1 decimeter = .1 meter
1 centimeter = .01 meter
1 millimeter = .001 meter

Two useful rules are emerging from all of this converting. One rule involves multiplying; the other involves dividing.

Rule One: To multiply by:

ten (10)	move the decimal one place to the right.
one hundred (100)	move the decimal two places to the right.
one thousand(1000)	move the decimal three places to the right.

Because one meter equals 1000 millimeters, then:

2 meters equal 2000 millimeters, and
3 meters equal 3000 millimeters, and so on.

Thus, the guideline for changing meter to millimeters is to *multiply* by 1000. Using this rule, the following are correct:

7. meters equal 7 0 0 0 mm
8.63 meters equal 8 6 3 0 mm
4.921 meters equal 4 9 2 1 mm

In each case the decimal has been moved to the right, three places.

Rule Two: To divide by:

ten (10)	move the decimal one place to the left.
one hundred (100)	move the decimal two places to the left.
one thousand(1000)	move the decimal three places to the left.

For example, in each sample below the decimal has been moved three places to the LEFT.

8000mm = 8. 0 0 0 m = 8m
6700mm = 6. 7 0 0 m = 6.7m
84320mm = 84. 3 2 0 m = 84.32m

REMEMBER

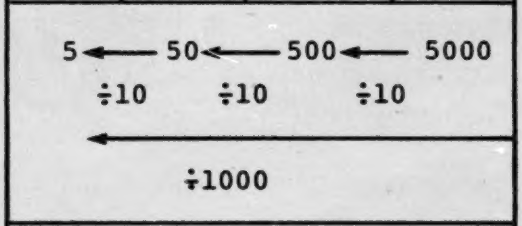
MULTIPLYING by 10, 100, or 1000 makes the number *larger.*
DIVIDING by 10, 100, or 1000 makes the number *smaller.*

Other units in the metric system operate the same way. Consider, as an example, 5000 grams of weight. Because there are 1000 grams in one kilogram (1000g = 1kg), you can DIVIDE by 1000 to convert grams to kilograms. Note these examples:

5000g = 5kg   86900g = 86.9kg
4600g = 4.6kg   700g = .700kg = .7kg

Remember, the amount has *not* *changed; you are merely* *renaming* *it in terms of another unit!*

Study these examples involving more metric prefixes in Figures 1 and 2.



kg	hg	dkg	g
5	50	500	5000
9.6	96	960	9600
.24	2.4	24	240

Figure 1

g	dg	cg	mg
500	50,000	500,000	5,000,000
9600	96000	960,000	9,600,000
240	2400	24,000	240,000

Figure 2

When all these prefixes are combined, a chart might look like this:

kg	hg	dkg	g	dg	cg	mg
5	50	500	5000	50,000	500,000	5,000,000
9.6	96	960	9600	96,000	960,000	9,600,000
.24	2.4	24	240	2400	24,000	240,000

Reminder: A column move ⇦ LEFT means you DIVIDE by 10.
A column move RIGHT ⇨ means you MULTIPLY by 10.

If you move right three columns, you multiply by 10 each column move, (10 X 10 X 10) or 1000. If you move left two columns, you divide by 100 (10 X 10). If you move left five columns, you divide by 100,000 (10 X 10 X 10 X 10 X 10).

Example One: To change 750 meters to centimeters, multiply by 100 because you move to the *right* two columns.

meters	dm	cm	mm
750		75,000	

Example Two: To change 4378.2mm to hectometers (hm), divide by 100,000 because you move to the *left* five columns.

hm	dkm	m	dm	cm	mm
.043782					4378.2

Of course, you know to divide by 100 (move to the left) if you wish to change 750,000cm to meters (750). Figure 3 on the last page illustrates this concept very well.

REMEMBER

When changing to a LARGER unit, the number will be *smaller*.
When changing to a SMALLER unit the number will be *larger*.

Example: In order to change 7.8km to meters, recognize you are moving to a *smaller* unit. Therefore, the number will be *larger* and you must *multiply* by 1000, moving the decimal places to the *right*.

7.8km X 100 = 7800. meters

Example: Change 590cm to meters. Because you are changing to a *larger* unit, the number will be *smaller*. You must *divide* by 100 (100cm = 1m) or move the decimal place to the *left*.

590cm ÷ 100
5‸9‸0.m = 5.9m

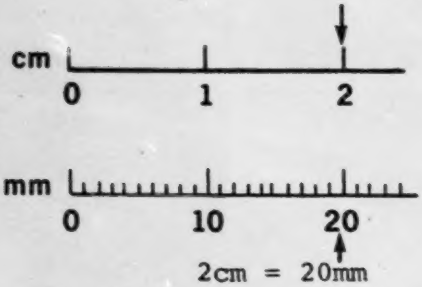
As you can see, the rules apply to conversion in meters, liters, and grams. Memorizing different conversion numbers (5280 ft. = 1 mile, 3 ft. = 1 yd., 12 in. = 1 ft., 4 qts. = 1 gal., 16 oz. = 1 lb.) is no longer necessary.

Note: Conversion should not be taught as a separate unit. Practice in writing conversions should occur just after the student learns how to read a measurement in two different units. For instance, if a student can read 122cm or 1.22m, that would be an appropriate opening for expanding into a mathematical rule. Measure first; then teach conversion later.

Teaching Strategies

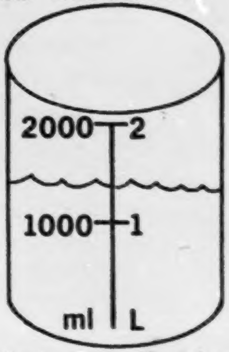
1. Begin with regular measurements. Use whatever unit you happen to be teaching. Encourage the students to discover two ways of measuring the same amount. For instance:

Length:

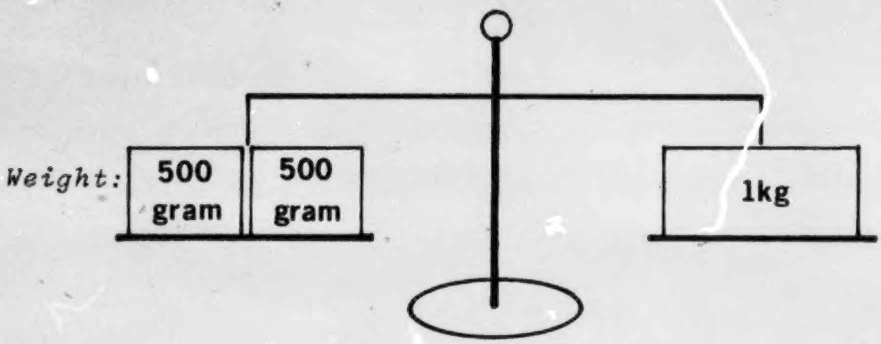


2cm = 20mm

Weight:



1500ml = 1.5 liters



1000g = 1kg

2. Discuss the relationships between the numbers. Ask some key questions, such as;
    - A) When do the numbers become smaller or larger?
    - B) How many times smaller (larger) is this measurement than that measurement?
    - C) How many times smaller (larger) is this unit than that unit?
    - D) What relationship is there between this prefix and that one?

3. Try to get the students to develop a rule that will work in one case. Then give another example. Do so until they have a universal rule.

4. Keep working from specific examples to generalities. Don't start with an abstract generality.

5. Offer lots of examples. The rules will probably come slowly for many, but don't be discouraged. Remember they will keep on using the same rules all through length, volume, and weight measurements.

6. On your chart of smaller and larger metric units, the decimal point will move in the same direction as when counting the columns. Always start with the given unit and move to the desired one: meters to cm.

7. To convince students of the relative ease of this system, ask them to do two conversions:

Change 3.5 yards to feet and then to inches.	Change 3.5 meters to dm and then to cm.
3.5 yds. X 3 = 10.5 ft.	3.5m X 10 = 35dm
10.5 ft. X 12 = 126 in.	35dm X 10 = 350cm

Note: Most students will convince themselves at this point; you needn't belabor the point!

Teaching Activities

1. Give the students some conversion problems that can also be measured in the classroom. Ask the student to figure the conversion first be moving the decimal point. Then measure the object to verify the conversion figures.

2. As you have the students practice measuring and recording those measurements, ask the student to write the answers using another unit. They may need to measure again initially.

3. Challenge your students to see how many different ways a measurement can be written.

4. See if your students feel comfortable enough to fill in this type of chart and can explain it:

km	hm	dkm	m	dm	cm	mm
1.234 =	? =	? =	? =	? =	? =	?

Teaching Evaluation

If you have done your teaching job well, your student will be able to:

1. Convert a measurement from one unit to another.

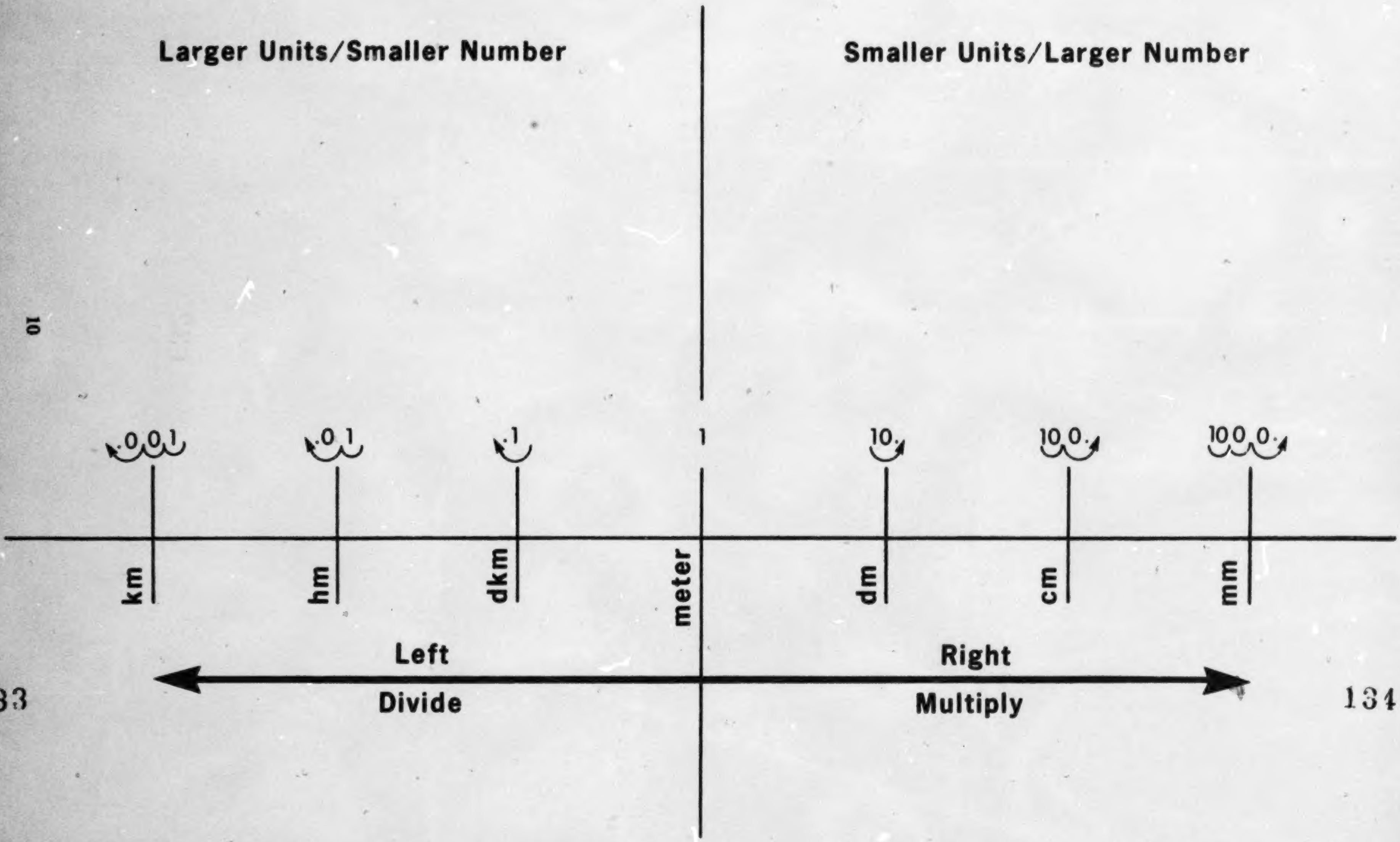
   35ml = ______l

2. Write a measurement in at least two different units.

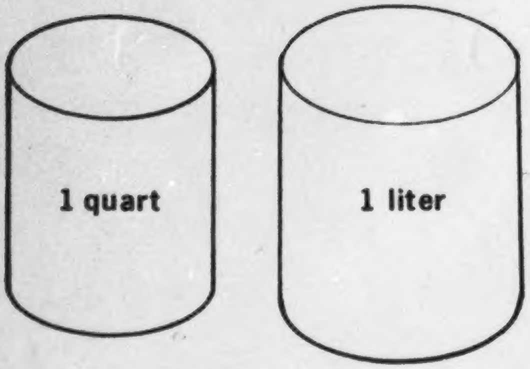
REMEMBER

Do not teach or evaluate conversion as a separate unit. Include conversion questions with the evaluation of the length, volume, and weight units.

Conversion Between Metric Units

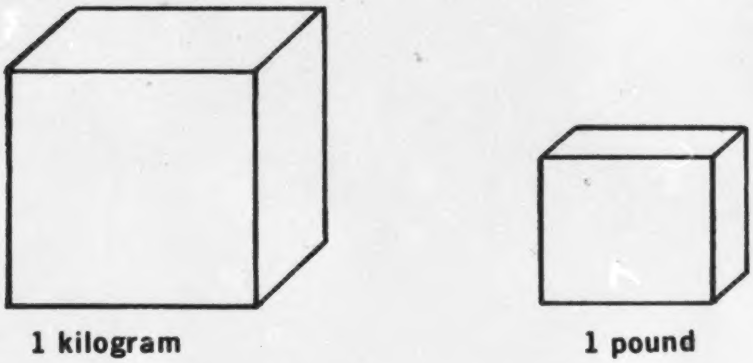

Larger Units/Smaller Number
Smaller Units/Larger Number
.0 0 1
.0 1
.1
1
10.
10 0.
10 0 0.
km
hm
dkm
meter
dm
cm
mm
Left
Divide
Right
Multiply

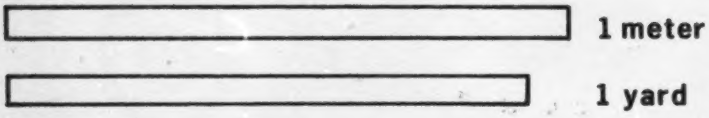
10


1 quart
1 liter

1 liter is slightly larger than a quart.

A kilogram is approximately 2 1/4 pounds.


1 kilogram
1 pound


1 meter
1 yard

A meter is 10% longer than a yard.

Common Comparisons of measurements